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BY
H. REINHEIMER
Author of "Symbiosis," "Evolution at the Crossways,"
"Evolution Re-Interpreted," etc., etc.

With Preface
BY
The Rev. Professor H. MAURICE RELTON, D.D.

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P. Allison

PREFACE.

It is with some trepidation that I respond to Mr. Reinheimer's request to write a preface to his work. Not being an eminent mathematician, I am reluctant to dogmatize in fields of research which are not my own. I should not like on the strength of college notes a quarter of a century out of date to subscribe to the necessity of an entire reconstruction of theology and if not the abandonment, at any rate the revision of fundamental articles of the Christian Creed because of the "general" acceptance of the Darwinian hypothesis. If, as Dr. Ritter suggests, the whole battle ground of evolution is to be fought over again and this time not so much between scientists and theologians as amongst scientists themselves, I should like to employ some of the respite thus afforded to an over-burdened dogmatic theologian, in contributing a friendly foreword to the labours of those who are attacking from many quarters a decaying and discredited system of philosophical materialism.

I am quite incompetent to express any opinion, still less to adjudicate upon Mr. Reinheimer's thesis. I should like to think that his conclusions are well founded and I may perhaps be permitted to express a hope that future research will tend to confirm rather than confound his main principles. Those who have profited in any degree from a perusal of Kropotkin's *Mutual Aid*, will turn with added interest to Mr. Reinheimer's claim that Symbiosis and what it implies in altruistic qualities is as primordial as the instinct for self-preservation and that the attainment of co-operation and of progress through

co-operation is of the very essence of the evolutionary process.

In the present state of our knowledge, it is, of course, premature to carry any deductions too far and it is above all things hazardous to generalize too freely in Biology from data which are themselves still the subject of dispute. Nevertheless whilst safeguarding ourselves from the charge of anthropomorphism in our study of Nature and remembering always that the argument from analogy depends upon the amount of truth in the resemblance, we may still welcome any fresh effort to uphold an ethical as against a non-moral interpretation of the evolutionary process.

In any case we must plead for a fearless and unhindered quest after truth and this the more earnestly inasmuch as it is necessary to enter a protest against Scientific Dogmatism. This is not the least of the obstacles to be faced by investigators if in the course of their studies they find themselves compelled to repudiate current shibboleths and to join the growing company of 'unorthodox' anti-Darwinians.

I hope that Mr. Reinheimer's new work will direct fresh attention to his previous contributions and stimulate other minds to an untrammelled canvass of the truth and error of Darwinism.

H. MAURICE RELTON.

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INTRODUCTORY.

"The time is indeed ripe for a critical revision of biological concepts. Let us scrutinise everything—even our most cherished scientific principles. . . . Neither science nor philosophy can give more than an abstract and colourless rendering of essential truth, which is approached perhaps most nearly by creative art." *Nature*, *22-10-27*.

When I undertook the task, many years ago, of championing, by a new synthesis, those apparently disconnected factors, *viz.*—co-operation, morality, and food as prime elements in evolution, I little realised that it involved my qualifying for the part of a Hercules in a new world. Whether or not posterity will endorse my claim to that title, there are very few, I feel sure, who would not have been appalled by the magnitude of the enterprise. Formidable obstacles of all kinds had to be overcome. More than one Augean stable had to be cleansed; more than one hydra-headed monster to be slain. In quarters where one might have expected the keenest appreciation, I encountered the most insensate and the most barbarous opposition. One must beware of entertaining the delusion that a man of learning is *ipso facto* a kind of saint, animated by a spirit of sympathy for the good, the true and the beautiful. The contrary is very commonly the case; and disillusionment will be the lot of him who sets out with such a presupposition. Disillusionment will also be his who imagines that a work of simple truth has a chance of succeeding when it bears the promise to destroy the vested interests of falsity. I am in agree-

ment with the view recently expressed by our greatest dramatist that savagery and pretence are the characteristic marks of the biological sciences of our time. With his wonted clear-sightedness and vigour he warned us against the tyrannous temper of the savage "scientist." Here is a piece of his bitter sarcasm aimed at the autocratic spirit of science: "Don't hamper yourself with a conscience. As a Man of Science you are beyond good and evil. No matter what you do, you can learn something from it; and the increase in your knowledge justifies your deed. Let yourself rip. Have a good time. Superstition is on your side. Ignorance is on your side. The dread of death is on your side. The Press is on your side. Parliament is on your side. Only a few notorious cranks are against you. And if you join the cranks you are a lost man, and will be prosecuted for malpractice by your colleagues, as for instance was Dr. Hadwen."

Immured in materialism, imbued by the "non-moral" view of evolution, morbidly afraid of taking a generous view of Nature, biassed against reform by habits and customs, timid of innovation, traditionally spiteful to "intruders," biologists are far from welcoming a new synthesis, whatever its merits, particularly so if it purports to make short shrift of their pretensions. They do not wish to be disturbed in their dalliance with physical science and its solid merits; nor do they wish to condescend to a union of biology with the despised social sciences. Co-operation, they pleaded with much bias, was only obscuring the outlook. Good and evil, they declared, were no concern whatever of so august a body as a faculty of biologists. Diet they held to be a subject suited to occupy only the mentality of a cook, but not that of an intellectual giant such as a biologist. Upon my devoted head wholesale condemnation was poured for bringing up the food factor at all.

And what was the attitude of the average man, who stood to benefit most from my endeavours? Indifferent for the most part to new thought, unaccustomed to weigh scientific evidence, reared in super-

stitious awe of "medicine-men" and similar "authorities," he preserved a sceptical attitude, and accorded little or no support. The remissness of the people in such matters was forcefully described by the aforementioned dramatist, with his unrivalled knowledge of human nature, thus: "Unfortunately, people know so little about science, and are so saturated with tribal superstitions which connect supernatural powers with appalling cruelties and terrors that they are easily persuaded that truth cannot be divined without horrible rites and sacrifices. When a vivisector says in effect, "I have a dread secret to wrest from Nature, so you must license me to sacrifice a guinea pig," the Sambo in us assents; and the more hideously the guinea pig is sacrificed, the more we feel the importance of the secret and the success of its extraction. And the magician can sell us anything as a cure next day, even without selling us the secret."

Fortunately a felicitous change is coming over physical science; and this may be expected to produce sympathetic effects upon biology. Recognitions, similar, or analogous, to those I have advanced, are being reached along other paths of thought, with every prospect, I venture to think, of ultimate convergence of these parallel pathways. Let me illustrate my point. Those acquainted with my views will remember that a vital cornerstone, with implications far and deep, is the idea of the symbiotic co-evolution of organic life, the mutuality of progressive life. Now it is a noteworthy feature that the advanced thought in physics to-day also inclines to give prominence to the "togetherness" of things, emphasising, although in different terms, their interdependence, as well as their joint evolution. Before long, it will have to be realised that a new biological orientation will be necessary, if only to keep pace with the progress of physics, and, whatever the reluctance at present, sooner or later orthodox biology will have to face the issue. Ere long biologists will be forced to abandon the dogmatic agnosticism of Victorian times, marked as it is by the pessimism of the brutal

thesis contained in Huxley's famous Romanes lecture on "The Destiny of Man."

Why is it that biologists are so loth to break away from Huxley? Because to him they owe their prestige and prosperity. But human thought will refuse to stand still at the bidding of obscurantists, be they biological or theological. Biology will progesss in spite of biologists, as it has done in the past.

Were it not for criticism, the yawning apertures in the Victorian system might not have been revealed ere now; and if we know to-day that Darwinism, so far from giving us any finality, as was thought, has raised more problems than it has solved, this is largely due to lay workers. Outside biological circles, belief in Darwinism is rapidly vanishing. No advanced thinkers now believe with Darwin and Huxley that the world is a bundle of fortuitous and disconnected facts, in which progress is a doubtful quantity; but they are able to envisage progress towards a certain end, according to a certain order. A few biologists seem now disposed to think that Huxley in his repudiation of natural ethics went to extremes.

In regard to the consideration of "morality," we have realised that, as the result of the spread of knowledge, morality is capable of discovering fresh meanings and implications every day, with the result that it appears in a much stronger light than in the days of Huxley.

Of particular promise, however, so far as the refashioning of evolutionary thought is concerned, are the fresh vistas opened up by the advance in physics during the last decade, and this well deserves mention here. The notion of a world in which energy turns out to be more important than matter, and in which substitution of space-time for space and time has made it natural to regard events rather than persistent substances as the raw materials of physics, is a very different idea from the notion of a world which till lately satisfied physicists.

Among the foremost exponents of the newer spirit in physics is Dr. A. N. Whitehead, who has worked out the implications of the changed foundations of physical

science in many ways, showing that the scientific materialism still adhered to by the biological schools is untenable and obsolete. He has presented us with the "principle of concreteness," implying the "togetherness" of things, and yielding a new way of designating God. By this principle, Dr. Whitehead marks the make-up of the universe as drawing all-being into the constitution of each man as well as of each dew-drop and of each historical civilisation. This principle was expressed by Tennyson in his line about the little flower in the crannied wall; "If I knew you, root and all, and all in all, I should know what God and man is."

In Dr. Whitehead's own words, identifying God with the order of the universe: "It is not the case that there is an actual world which accidentally happens to exhibit an order of nature. There is an actual world because there is an order in nature. If there were no order, there would be no world. Also, since there is a world, we know that there is an order. The ordering entity is a necessary element in the metaphysical situation presented by the actual world."

No one can read these lines without realising that we are travelling far away from Darwin and his outlook on life. Few would have anticipated, fifty years, or even twenty, or even ten years ago, that physics would thus lead us back to God, to a new realisation of the immanence of good and evil in the whole field of science.

According to Dr. Whitehead's teaching, God is not everything, and every thing is not God. "The whole existent world taken in its totality is not God. On the contrary, God is simply this one sustaining all-pervading character which the universe displays, the principle of concretion, the constitutive, aesthetic order of all being. God is both more and less than the total concrete world of things in which we live. He is less because he excludes evil. Evil is the principle of discretion or anti-concretion. It is that which runs counter to, and breaks down, the constitutive aesthetic order of the world. It is that which hinders and obstructs the participation of all in each. Hence it is the very

opposite of God and the antagonist of God. It is the destroyer of concreteness, as God is the sustainer and promoter of concreteness. Of course, evil could have no being if there were no concrete world to tear down. The disordering principle of evil could have no being if there were no order to disrupt. Evil could never completely triumph, for in the very moment that it destroyed the concrete order it would destroy itself. It would have nothing on which to feed, no standing ground. Evil is a parasite on the goodness of God ; but God and evil are mutually exclusive." (H. N. Wieman on Prof. Whitehead's concept of God, *Hibbert Journal*, July, 1927).

In language not very dissimilar to that employed by myself, Dr. Whitehead thus insists on what is perhaps the strongest point in my theory, viz, the necessity of drawing the vital distinction between good and evil, of separating the chaff from the grain, in practically every department of the universe. Be it here recalled that my theory is briefly this—that the standards of virtue and vice in the universe depend upon two antitheses : symbiosis and parasitism ; that it is definitely immoral and ruinous, through the whole of nature, for an organism to be parasitic ; that the degree or virtue is the degree in which an organism co-operates or " gets on " with the universe, living by helping the rest of creation. Those who will peruse Dr. Whitehead's " Science and the Modern World " will there find that the author in so many words concedes to Symbiosis a place of great importance.

As an example of the way in which " morality " has gained new meanings and is now receiving renewed vindication, I might here allude to a valuable article contributed by the Rev. Dr. Joseph Fort Newton on " The Higher Fatalism " to the *Hibbert Jounral*, July, 1927, in which it is shown how determinism may be transcended by newer and better views on Nature, and how " morality " may be legitimately viewed as a general attribute of the universe. At the risk of being called anthropomorphist, I have always insisted that man and

his values are not a separate department of Nature, and that, on the contrary, human experience is of the very essence of biological experience—also saying, long before Dr. Whitehead's book, (insisting on the value of naíve experience) came out, that many of our poets rank high as biologists. So much has it been the custom of scientific men to regard man as standing outside Nature, as forming, in Huxley's words, an *imperium in imperio*, that we have mistaken a part for the whole and endeavoured to live in a world with but one hemisphere. But there need be no such dilemma, as I have often shown, and as Dr. Fort Newton tells us in the following: "Man is neither exile, alien, nor exotic in Nature; he is her child born out of her deep heart through ages of travail—he of her dust, she of his spirit—and his moral life is as much a part of her process as his physical frame. Moral law must somehow be mixed in the stuff and fibre of things, else man would not know it at all, much less be ruled by it. Nor does it matter to what far past the moral sense of man is traced, or to what lowly beginnings: it is here; it rose with him, a life-star, out of the depths; it abides and grows—a ray of white light in the dim country of the world. The great mystery of the life of man is not sin, but that which reveals it, condemns it, and makes it at last unbearable. Either we must admit the miracle of a moral being in an unmoral order, or the moral sense of man must be allowed to interpret Nature; the more because it points the path along which the line of advance lies. Or, finally, if Nature be unmoral, the moral life of man bears witness that she is not all—there is something more and higher in the constitution of things."

By thinking things together, in conformity with the new physics and the new biology we find that the higher life of man has a basis in the order of things, and is not a plant growing in the air. Justice is hidden in Nature; we must look for it where it is revealed. In endeavouring to establish the importance of the symbiotic pathway of life, I have frequently met with the objection that it would appear to involve responsibilities too great to make

it a practical possibility. The idea of order and orderliness makes no appeal to Darwinism with its masterwords of chance and irresponsibility. As though all could go as they pleased, as though righteous principles were not to count! It is Dr. Fort Newton's view that Fate is a fact, profound, elemental, overwhelming, inescapable, "held in solution in all religions, the first fact of experience if not the final conclusion of all philosophy" . . . "It is a tyrannous fact if taken out of its context and misread—as, alas! it nearly always is—terrifying if wrapped in superstition . . . but if interpreted aright it is like the sky above and the river-bed below the flow of mortal years. At least it implies order, in contrast with the awful miscellaneousness of mere Chance, in which forces move at haphazard; a direction and rhythm in the nature of things which, if men follow it, leads to power, but

"Omitted, all the voyage of their life
Is bound in shallows and in miseries."

One way is right to go; wisdom is to discern it, obey it, and move on that aim; then all things work together, and the Seven Stars are the friends of men."

Often have I shown that the symbiotic pathway of life, narrow though it seems, is the one that implies conformity with the powers for good implicit in the universe. It is better to rely upon Symbiosis than to gamble with Chance. Even "Fate" may be said to have its advantages. As Dr. Fort Newton says: "Fate at any rate is dependable and intelligible; it imparts a kind of unity to the world, and even a dignity to human life," and he fittingly quotes Emerson (that great evolutionary thinker), in this connection: "Nature is what we can do," and "if Fate is all-pervading, man is also a part of it, and a part of Fate is the freedom of man albeit not such freedom as man often imagines that he has."

CHAPTER I.

Symbiosis.*

For some thousands of years it was known that beans or some kindred crop form the best preparation for the cultivation of wheat, and that a rotation which will preserve the fertility of the soil must include a leguminous crop. It was left to modern science to discover the true inwardness of this important fact, the implications of which go deep and far.

We know now that the plants principally concerned—that is, the Leguminosæ harbour "nodules" upon their roots, consisting of colonies of bacteria, which bacteria live in a relation of symbiosis with the leguminous plants. It is due to this co-operative alliance with bacteria that the plants obtain their all-essential supplies of nitrates. The plants and the bacteria help each other by exchanging their spare products. This mutual relation is one of systematic and reliable reciprocity with all that this involves in character and in disposition. Alliances of this kind are indispensable to life.

There is nothing fanciful in this account of the phenomenon. It corresponds with the facts. Indeed, we are here dealing with one of the great facts of Nature. Apart from symbiosis there are no natural processes by which the gas nitrogen could be brought into combination in any workable quantities. Hence the problem had to be solved bio-socially—that is, by invoking the services of the humble bacteria. The

* The substance of this chapter appeared in "The Medical Press and Circular," April, 2nd, 1924.

bacteria, as the *British Medical Journal* stated, November 18, 1922, " were not created for the express purpose of inconveniencing or punishing man, they came into existence to perform an indispensable function in Nature, and life on this planet is possible only in consequence of their incessant activities."

The importance of bacteria, capable of fixing atmospheric nitrogen and of converting it into suitable food for the plants, constantly increasing the stock of plant food in the soil, is almost inconceivable. Agriculture and civilisation, depend upon this fundamental fact, which is also to say that they depend upon symbiosis. Apart from symbiosis, the alliance of the leguminosæ with bacteria would not pay, a fact which would preclude any real success of the bio-social method.

It is not enough for the nitrogen to be fixed. The nitrogen which is fixed has to be converted into nitrates. This, too, is due to bacterial agency —that is, to groups of bacteria symbiotic amongst themselves. The synthesis is effected by symbiotic bacteria. There are other bacteria, of course, which, so far from being synthetic, are active in the disintegration of living matter. Jointly, these two kinds are instrumental in effecting what has been termed the nitrogen cycle.

The number of plants which live in active symbiosis with " microbes " is legion. The higher plant is able to spare some of its carbo-hydrate surplus in exchange for nitrates. It has been found that a continuous supply of carbohydrates from the green plant is a prime condition of the nitrogen synthesis. By this I mean that the bacteria, like other humble workers, require to be remunerated for their labour. The higher plant acts as the fundamental capitalist in the matter.

The task of the scientific agriculturist of the future may be said to be this : to render the soil habitable for a desirable microscopic soil population. To do this he will have to encourage the good citizens amongst the soil population and to discourage the bad.

What are the good citizens in the soil, and how do they live ? It is of vital importance for us to understand the

conditions under which our invisible helpmates in the soil are able to flourish. For the more we help them, the more can they in turn help us. The good citizens of the soil population are what I have termed "cross-feeders," in contradistinction to the bad inhabitants, which are "in-feeders." Our task as scientific agriculturists is to aid the "cross-feeders" and to suppress, or limit, the "in-feeders." For the cross-feeders are the true pioneers, the synthetic organisms, which enrich the soil, since they alone excel in symbiosis.

By "in-feeding," on the other hand, I mean the indolent appropriation of food manufactured by close relatives and the correlated shirking of the economic duty of production, or of counter-services in some kind I have endeavoured to show in all my writings that symbiotic cross-feeding represents the progressive path of life, whilst in-feeding represents that of suicidal evolution. It has long been known, of course, that ultimately all animals depend for their sustenance upon the plant. But it can now be shown that there is an unwritten treaty between the plant and animal kingdom whereby the gifts of the plant enure pre-eminently to the benefit of the symbiotic animal.

How can we assist the good microbes in the soil? One practical method has been found to be that of keeping down their enemies by means of sterilising the soil, both by chemical and physical means. It is a rough-and-ready, drastic treatment, but based on the knowledge that the good organisms are more resistant to adverse conditions than the bad, the predaceous ones, which, as in-feeders, indolently prey on the toilers and, in doing so, lose their vitality. Add to this loss of vitality that of sympathy on the part of the highest organisms, or, worse, their actual antagonism, and it is plain that the survival of the honest organisms is generally better assured than that of the dishonest.

It has been found that in the last analysis symbiosis is concerned with food, although biologists have not seen fit hitherto to go beyond this important fact and to scrutinise its significance. In my view of the matter,

there has to be this relation for several reasons. Food is too important a matter to be left unregulated, and symbiosis is a means of regulation. Symbiosis renders the elaboration and the supply of food subject to the maximum good of life, as may be demonstrated by the case of the Leguminosæ. These useful plants, as already indicated, with their wonderful disposition to symbiosis, enrich the soil in pioneer fashion, rendering it increasingly fit to sustain the life of other useful organisms. By their activities and behaviour they avail towards life generally, in accordance with Ruskin's definition of usefulness, which should figure in biology quite as prominently as in political economy, that "a truly valuable thing is that which leads to life with its whole strength."

One kind of leguminous plant often suffices to store up in the soil sufficient nitrogen to furnish by its own growth and decay, organic matter, which is requisite for other staple crops. A species of Japanese clover has been the salvation of hundreds of thousands of acres all over the cotton belt of America and north of it, a fact of great significance from a sociological and bio-social point of view. We are warranted in claiming a great part of the credit for symbiosis.

Symbiosis entails a definite pathway of life, a steady and reliable disposition for work, for industry, for social behaviour, and, accordingly, a considerable degree of restraint in matters of food and reproduction. It has been shown that sulphur bacteria, which are responsible for the pure sulphur in the world, thrive best on a mineral solution, and that organic sources of nitrogen and carbon are without favourable influence on the growth of these bacteria. That is to say, these bacteria are useful as cross-feeders. Many of them, moreover, require free oxygen, which is supplied in Nature by associated green plants—that is, by partners in symbiosis. Such partnership means nothing less than this: the substitution of social for anti-social methods, of fair play and fair compensation for theft and murder. Live and let live is indispensable in life. Compensation

is the rule. Symbiotic partnership, of course, means division of labour ; and all this involves specialisation. Whilst the plants specialised increasingly as producers of carbohydrates and of oxygen, their partners amongst animals, bacteria, and fungi, relieved the plants, by other specialisations, from many domestic duties, so as to render the gains of the plant again beneficial to them. In other words, plants and animals became socio-physiological partners, and jointly forged the links of progress. Evolution is largely based upon this fundamental fact.

The reciprocity between microbes and the higher organisms, constitutes intra-cellular symbiosis. There remains the vast and important field of co-operation between animals and plants, (over and above intra-cellular symbiosis), coming under the head of what I have called " norm-symbiosis," since it is of determining importance in life and in evolution. This is the symbiosis to which I assign chief importance. The subject may well be broached in conjunction with that of the vitamins, the accessory food substances, as they have also been termed, the discovery of which has revolutionised the science of nutrition. The most remarkable fact concerning the vitamins from our point of view is that they are products of plant life. The vitamins are indispensable to the growth, the health, and the evolution of the animals. Think what this means ! It shows the animal to be determined by the plant to a degree bordering on the miraculous, unless we take the view that in course of evolution mutuality between plants and animals has been so paramount and persistent that the two have come almost to be related like the sexes, like male and female that is, that they are one in reality though separate in appearance.

The action of the vitamins is in a sense the alternative or opposite to that of the alkaloids, the vegetable poisons, which are of appalling efficacy in animal physiology, and which the plant manufactures in self-defence against the predacity of many animals. Hitherto the significance of the alkaloids has scarcely been

realised. In their case, too, we meet with an astounding awareness on the part of the plant—an awareness in respect of the phsysiology of the animal and of the way of effecting it for good or for evil. It is a significant fact that the plant bestows blessings or curses in accordance with the treatment received at the hands of the animal. The phenomenon goes far to prove that righteousness is fundamentally striven for in Nature. There is only one kind of freedom to be desiderated, according to Huxley: the freedom to do right; and it may be said that this is the freedom sanctioned by Nature. Things refuse to be mismanaged long. The mutual accommodation of beings demands obedience to the law of co-operation. The deadliness of the alkaloids proves that evil must result from animal transgression against the law of co-operation. The beneficence of the vitamins, on the other hand, shows that the needs of the animal are ideally provided for by the plant, so long as the animal abstains from depredation.

CHAPTER II.

Good and Bad Ways of Living.

"We have all been brought up on the mechanistic theory, as represented in the writings of such men as Huxley, and embodied in present-day popular literature. It is thus an intellectual wrench to abandon this theory; but, though it may survive as a widespread form of belief for many years, abandon it we must." *Dr. J. S. Haldane.*

Fecundus est error. The denial of evil in Nature is an evil inheritance left us by Darwin who had imbibed it, rather uncritically, from the "damned professors" of Germany.

The facile imputation of "non-morality" to Nature, since proclaimed from the housetops by Darwin's followers in the name of science, has, unfortunately, had no small share in the undermining of the moral fibre of the modern world. In reality there was little science behind the sophistry, which one may regard as rather of the nature of a counsel of despair. For, immured as they were in scientific materialism—a closed system, arguing in terms of itself, and far from being a complete description—biologists found themselves incapable of dealing with values, and made it convenient to shelve the difficulty by denying the moral sense to Nature altogether. For the same reason, science has not even contemplated that practical union of biology and sociology, without which, as I have often insisted, real progress is unattainable.

Another fatal error, bequeathed by Darwin, was that of placing far too facile a complexion on fitness, a term which is still far too glibly used when neither health nor disease, nor the distinction between the two

are at all understood, when only the haziest notions with regard to evolutionary efficiency are entertained. All this has tended to pervert the biological outlook, so much so that biologists have come to take the abnormal phase of life for the normal, saying good-bye to common-sense altogether. They argue in terms of expediency and not of principle. Mere reproduction, and mere adaptation, however expedient and transient in importance, have come to be regarded as the sole criteria of success, and as the *summum bonum* of evolution. Considerations of quality, of status, and of morality are ignored, as though they were non-existent. On this closed system of science, the liver-fluke, since it reproduces and "adapts," is as much amongst the peers of existence as any noble form of life. Parasites, despite their degeneracy, are amongst the very "fittest," nay, they are the "most venerables" of Darwinism, since they are seemingly veritable adepts at multiplying and "adapting."

It is no wonder that that fell disease, cancer, involving as it does, the problem of the parasitism of the cancer cell, offers the most profound puzzle to biologists, seeing that they are so august as to be "beyond good and evil."

The Darwinist may tell us that the cancer patient is one who has not obtained the "favour" of Nature and is, hence, in course of being naturally selected; but how does such cheap wisdom avail us? Not at all. As Dr. J. S. Haldane says (*British Medical Journal*, 21.5.27), "If the mechanistic biology represented truth, we might despair of anything further than preventive Medicine of a very restricted kind." If in a family both parents die of cancer, bequeathing a less resisting power to their children, might we not, according to Darwinism, have to consider such a stock as of the "fittest," inasmuch as at any rate there is a progeny? Could anything be more indiscriminate, or more absurd? By the same reasoning, if other parents, too feeble and too degenerate to maintain themselves by honest labour, should turn parasitic towards the community, by becoming crooks

or prostitutes, such stock, according to Darwinism, might have to be regarded as amongst the "fittest" so long as there is at least a power of parentage.

Like others of Darwin's concepts, "fitness" is far too generalised a notion to be of practical or scientific use. In some vague algebraic sense these concepts may be said to have their use. They are usable as x, y, z, pending the elucidation of the exact values for which they do service, upon which elucidation, however, a totally different picture from that presented by Darwinism may be emerging.

How could there be "fitness," involving a high degree of integrity, without at least some considerable degree of "physical morality"? Yet morality is altogether ruled out by Darwinism.

The casuistry usually adopted in support of the fallacy that parasites (although they may be "otiose") are (yet) normal and "fittest" is so contrary to all common-sense that one might despair of the mentality of the generation accepting it. It is as though we lacked moral and philosophical backbone, as though we were so greatly addicted to iniquitous practices as to find criminality admirable in others. Let us take some concrete examples in illustration of the way in which iniquitous behaviour in Nature is falsely being condoned in the name of science. The vile parasitism of the Ichneumonidæ, the Ichneumon flies, is well known to naturalists. Nearly 6,000 species of these Hymenopterous insects have been described, and nearly all are marked by parasitism. Most of the species in the larval state, live inside the larvæ of Lepidoptera, and thus, whilst being themselves condemned to inferiority, keep the myriads of caterpillars within bounds, the numbers of them destroyed by Ichneumons being prodigious.

The Ichneumonidæ are probably the most purely carnivorous of all the great families of Hymenoptera. I would regard them as representing the opposite pole to the vegetarian and social tribes which stand at the head of the hymenopterous order and as illustrating my

contention that weakness, inferiority, and retrogression are the result, and also the nemesis, of parasitic, infeeding habits. I know full well that, as scavengers, these insects have their use. But then, of course, disease generally also has its use. My point is that parasitic creatures have an increasing interest in evil, that, from the point of view of progressive co-evolution, they constitute a satanic, or quasi-satanic, influence, analogous, indeed, to that imputed by Gœthe to the poor devil, Mephistopheles, who was "a part of that power which still produces good, while it deviseth ill."

One must consider anything good which furthers the scheme of co-evolution by Symbiosis; anything which is calculated to frustrate that scheme, constitutes a clog on the wheel of creation, and must be considered bad. To the last category belong carnivorism and parasitism, which are one in principle.

Conditions similar to those among the Ichneumonidæ are known to exist among the Braconidæ, the Supplementary Ichneumon-flies. These, too, are bred parasitically in great numbers from pupæ and even from imagoes of other insects, the eggs having been laid by the female upon the offspring of other insects. According to the *Cambridge Natural History*, as many as 1,200 specimens of Microgaster have thus been reared from a single Lepidopterous larva. Here is the comment which the learned authors of that publication have to make with regard to this parasitic way of life. "Although such parasitism arouses a feeling of repulsion, yet there is reason for supposing that there is little or no cruelty or acute suffering connected with this mode of life." The victim attacked, they declare, is not eaten, the parasites in the interior taking in the lymph of the caterpillar either by the mouth or by endosmosis, but not biting their host. How "considerate" some of these parasites are! The host, we, are further assured, displays no signs of sickness, but eats voraciously, so that it serves merely as a sort of intermediary between the juices of the plant and the larvæ inside itself. This, however, is by no means the whole story,

as we shall presently see. The professors merely wish to demonstrate how admirable and forbearing the parasites are, seeing that, according to them, the exploited scarcely notice the exploitation. So Thrasymachus, the sophist in Plato's *Republic* argues that evil done in perfection ceases to be evil. As almost invariably happens in these academic descriptions, the real story of the damage inflicted by the parasite comes at long last, after we have learnt to admire the creature for its "adaptability." Presently, then, we are duly told that "it is only when the metamorphosis is at hand that the host sickens." But even this admission of serious harm done by parasitic imposition is to be watered down by subterfuge—by appeal to a subject which biologists have little cause to invoke, since, admittedly, they fail to understand it—to wit, natural immunity.

Not always does the parasite succeed in its nefarious work, for often it meets with too much resistance from its intended host. Parasitised larvæ may change into pupæ, and they may occasionally even become perfect insects. Cases are known in which imagoes have appeared with some of the small parasites embedded in some of the external parts of their bodies—they have been extruded, as in other cases they may be engulfed by the cells, or decomposed and returned to their elements by an incarcerating process, when they are imprisoned in a veritable oubliette. But though the resistance of would-be hosts is often too high for successful imposition, this does not exculpate the parasite.

In the case of the Braconidæ, moreover, the authors of the *Cambridge Natural History* are obliged to admit that lucky escapes of hosts are rare and that "in the enormous majority of instances the host is destroyed either when it is in the larval stage or before the pupa has advanced to any great extent in its metamorphosis to an imago, all of which shows that parasitism is an evil, at least in the sense in which disease and ordinary sin are evils. Even if it be true that as a rule parasites attack creatures which are in a deficient state of health

and vitality—elimination of moribund organisms being the mission of scavengers—it will not do to depict parasites as innocent of crime, in view of the interest they have in evil.

We have never been vouchsafed the full story of parasitism from its true inception to its close. We have been furnished only with parts and travesties of the truth, and this has rendered it possible for the morbidity, the criminality and the nemesis of parasitism to be slurred over or even to be denied altogether. The roots of the evil go back to trespasses against constitutional law, demanding restraint and austerity in the interest of all. There are, as we shall see, animals over-indulging their appetites, with a minimum of counter-services, at the expense of the plant, veritable "plant-assassins," which, though still cross-feeders, must yet be considered as unrestrained and savage creatures and as having become guilty of parasitism.

The plant, despite its wonderful powers of production, of reproduction, and of regeneration, despite its primordial training in the rôle of universal provider, can yet endure only a limited amount of exploitation, and it stands in danger of being exterminated by the unchecked depredation of plant-assassins, the voracity of which would appear to know no bounds. That such unhealthy creatures should be deterred, checked and penalised, as far as possible, is as natural in the economic scheme of things as is the fact that the really serviceable animals, fungi and bacteria are remunerated for services by the "fundamental capitalist" which is the plant.

Undeniably, retribution forms a big chapter in the book of organic life, thus showing that the predatory principle has not such sanction of Nature, as the orthodox ask us to believe, and that the moral imperative rules the lower creation, just as it does the life of man, despite the protestations of the schoolmen that they cannot see any signs of it.

Large numbers of caterpillars, for instance, show themselves to be true plant-assassins, by gorging voraciously on plant-food, until they become choked,

obese, and moribund, in which pathological condition they "naturally" attract more pronouncedly parasitic scavengers, whose life mission it is to occupy morbid "soil" with a view to the elimination of those elements that exist on the wrong principle of life, and in so doing, seriously endanger the well-being of the community as a whole. Evolution proceeded from the creation of small wholes to ever larger wholes, but not without instituting appropriate safeguards, giving increased security to the more evolved and more precious whole. Were it not so the more exalted creatures could scarcely protect themselves against the inroads of the more savage, less disciplined, and more easily perverted, lower ranks. *Vraie noblesse, nul ne blesse.* Only austerely constituted organisms can hope to enjoy natural immunity from disease.

We may profitably glean another principle of pathology from the aforesaid fact of the compulsion that many creatures are under of having to feed, not only for themselves, but also for their associated parasites, which they have evidently allowed to become quasi parts of themselves —parts, however, that do not really assist them, but, on the contrary, slowly undermine them. If, by bad habits and customs, we lay ourselves open to the invasion of parasites, we may be compelled to consume, on that account alone, far in excess of normal physiological requirements, and also, as far as quality is concerned, in a manner not at all in conformity with our true physiological requirements, a course which is full full of additional dangers. Through being slaves to habits, we may become slaves to other creatures before we even know it—creatures, moreover, which have an interest in evil, and whose good is our evil.

So far as the parasite's penalty is concerned, we get, apart from its degeneracy, which grows in proportion to the intensity of its evil habit, at the terminal phase, very marked forms of hyper-parasitism, this again showing that the checks to depredation arise as naturally as do the increases of organisation in a normally living,

normally striving creature. The parasites of the over-fed caterpillars are in turn parasitized by others, and the latter, in their turn, by tertiary parasites, which, again, may be infested by quarternary parasites, still more degenerate. We thus get a constantly intensifying vicious circle—the opposite in every particular of that symbiotic circle which shows healthfulness and fruitfulness all the way round. Orthodox biologists seem incapable of drawing these important distinctions.

They have hitherto derided my exposition of Symbiosis, as that of parasitism—as being too idealistic on the one hand, and too pessimistic on the other; they have found me guilty of "anthropomorphism," for bringing what we may call ordinary common-sense to bear on natural phenomena, and they have derided my idea of morality in Nature, which I had based on the fact that you cannot have integration in Nature without corresponding degrees of integrity, involving at least physical morality, closely akin to the ordinary human morality.

Now comes the opinion of Dr. Haldane, when lecturing on "Biology and Medicine," to the effect that the study of biology must naturally begin with the study of human life, as I have always insisted. It is in the lives of the most highly organised organisms, according to Haldane, "when they are physiologically intact" that we can discern most sharply and easily the "wholeness of life." "In so far as human life is accessible to observation, human biology tells us more, and tells it more clearly, than does the biology of lower organisms. The human subject of observation can himself tell us what animals cannot tell."

The same biologist also expresses entirely my own mind when he declares that the search for imaginary "mechanisms" diverts us from the search for what can be more readily found. Attention has thus been called away from the truly wonderful powers which our body possesses for internal regularisation, co-ordination, and co-operation—the whole gamut of fine qualities which I have collated under the terms Symbiosis, integration,

integrity, physical or bio-morality. Says Haldane: "Regulation or co-ordination means nothing fundamental for the mechanistic physiology, and thus receives very little attention, or is twisted round so as to be made to appear as if it were nothing but a sort of mechanical balance, dependent on innate peculiarities of structure or composition. It is common, for instance, to speak of the regulation of reaction in the living body as if this were an equilibrium of acid and base, maintained approximately steady by the presence in the body of buffering substances, instead of by physiological activity. Language of this sort is imagined to be scientific: it seems to me only evidence of lack of scientific insight."

I have shown over and over again that it is due to such and similar shortcomings that neither Symbiosis nor parasitism has been understood by the schools, and that the two contrasting concepts have been quite indiscriminately mixed up one with the other, with the result that biological science has remained chaotic and quite incapable of inspiring medicine as it should. We shall presently see how a writer (Dr. Root), representing the mechanistic view of parasitism, finds himself in conflict with views that would natuarlly commend themselves to practical medicine, and it is interesting to find Dr. Haldane protesting that mechanistic physiology, in laying no primary stress on co-ordination or regulation, has tended to divorce itself in an unsatisfactory manner from practical Medicine. "It is life as an essential co-ordinated whole" he says, "that physiology, no less than practical Medicine, has to keep in view. Practical teaching which consists mainly in experiments on isolated fragments of frogs or other animals, and in isolated chemical experiments on substances occurring in the body, is no satisfactory instruction in Physiology as a science."

It is to be hoped that in the future, through adequate previous knowledge of human life, students will be able to bring a better and more open mind to the study of Nature, which will be to the good of all concerned. Should schoolmen turn to my books they would find

that a considerable amount of work along such lines has already been done; and in what follows it will be shown how much more can be done, if we will but free ourselves from bygone views.

Our real subject being ways of life, let us turn in the first place to the ways of those creatures which would seem to reflect our own ways most nearly and see what examination has to teach.

According to Lubbock, if we judge animals by their intelligence, as evinced in their actions, it is not the gorilla and the chimpanzee, but the bee, and above all, the ant, which approaches nearest to man.

What does this mean? According to the theory of Symbiosis, and on due consideration of all the facts, it means that exaltation of type—progressive evolution—is most ideally established on a vegetarian basis, carnivorous and parasitic ways of life being here entirely ruled out. Let us see. There is every indication to show that the social states of the insects, in order to become truly successful, must be run on vegetarian lines. In the absence of such a beneficial physiological basis of life, the development of the insect states would have been unthinkable, since it is on a vegetarian basis alone that true gregariousness can be achieved in Nature, and gregariousness is the forerunner of the social state. It is an incontestable fact, though one usually slurred over by biologists, that some foods are specially calculated to promote gregariousness, whilst others are, on the contrary, prone to induce solitariness. Solitary species are commonly those characterised by predatory and "in-feeding" habits, and, according to my theory, inasmuch as this is the case, they are inferior to the gregarious "cross-feeding" species. The beasts and birds of prey, the serpents, and spiders, the legions of predaceous insects, all lead solitary lives; whilst the herbivorous, graminivorous, and frugivorous birds and plant-eating snails and insects are more or less gregarious. According to Prof. Morton Wheeler, of Harvard, the ants, in particular, exhibit a progressive tendency to resort more and more to a purely vegetarian regimen

as the only means of developing and maintaining populous and efficient colonies. He states that the facts force even those who, like himself, are not vegetarians, to confess that the trend of evolution in the most interesting of social insects is towards ever-increasing vegetarianism. The significance of such facts goes far and deep. Whether we personally like vegetarianism or not, has nothing whatever to do with the argument. We must establish the truth, whatever it be—the truth with regard to the best way of living according to Nature. Here we have a crucial test, the like of which it is not easy to find elsewhere; for the experiment of Nature, if we are to call it so, has extended, not over one or two, but over thousands of generations; not over some few years, which might furnish only transient results, but over ages of time, involving even geological changes of a serious nature. Tests of this kind cannot be invalidated by the glib talk one so often hears regarding these important matters. Genuine success, as measured by the highest values that we are able to apply, can, it seems, be achieved only on a vegetarian basis. Such a basis, as I have often shown, is calculated to be most in conformity with the scheme of symbiotic co-evolution between plant and animal, frustration of which scheme involves evil.

Social and physiological integration, sympathy, and intelligence are best fostered on a vegetarian basis—to be more exact on a basis of symbiotic cross-feeding. All else is apt to favour disintegration. We have here a strong sidelight on the causation of cancer, where the whole evil may be summed up, as I have often shown, by just this: lack of gregariousness (and of Symbiosis) on the part of the cells of the body, due, for the most part, to carnivorous or unsymbiotic feeding habits! The behaviour of the cancer-cell, which cell, by consensus of opinion, is a parasite, is often attributed to "reversion"—that is to say, the cell, instead of conforming to high and evolved degrees of mutuality, tends to return to the license of a more primitive existence with less

developed mutuality. It is like a retrogressive step in evolution—like degeneration, in fact.

Now the analogy of insect evolution shows in what further sense the behaviour of the cancer-cell betokens a reversal. In earlier times, the ants, for instance, showed less evolved gregariousness, which is not to be wondered at, for they then subsisted chiefly on a fleshy diet. The carnivorous regime is that of the primitive species, according to the best authorities. It is probably new to many readers that there are also vegetarian beetles which live in societies, which milk termites, and which cultivate nutritious fungi. Wheeler describes several, and he is of opinion that some of the social insects domesticate more animals than we do, and, probably, cultivate more food-plants than we do. In many cases the cultivated plants are bequeathed to succeeding generations.

The truly wonderful results of vegetable sustained gregariousness amongst insect communities go a long way to indicate that also in the great steps of evolution which life has taken during its long ascent, a duly restrained partnership with plants—Symbiosis on the grand scale of Nature—has been the main factor of progress, as, indeed, I have often shown it to be.

Only too often it is overlooked by advocates of warfare, for instance, that it is in the first place from the arts and crafts of the honest and humble industrial life that the power for war is derived. A bee, for instance, needs so many tools in the daily work—such a variety of combs, brushes, pincers, shears, and what not—that the body is fairly covered with handy appliances. The very legs of a bee are adapted to the purpose of an active, industrial life. An American writer, speaking of the "bee's knees," states as follows: "Any skilled workman, however little he might know about nature, would quickly conclude from an examination of the working parts of a bee that here was a fellow factory-hand who knew the tricks of some highly technical trade. Every hair and joint from head to foot has some special development which makes it an ingenious combination-tool,

without interfering with the proper working of the bee's own person. The leg of the bee—and I am not here forgetting that there are six of them—has a greater number of joints than has the leg of a human being. In each of the three pairs of legs this knee is differently developed so as to furnish the bee with three sorts of very useful tools—pincers, crow-bar, and comb."

It is understating the case to say that the success of the vegetarian diet in Nature depends on, or is merely due to, the greater abundance of vegetable fare. I have often shown that it is in the first place the great evolutionary adequacy of such fare that counts for most in this matter, and that, indeed, the very abundance of the right vegetable food depends, in turn, on adequate counter-services rendered by animals to their food-plants, as the example of ants, bees, and beetles, cultivating their own food-plants, copiously shows.

On due consideration of the differences existing between the three groups, said to stand at the head of the hymenopterous order—the ants, bees and wasps—one is impressed by the great inferiority of those characterised by the lesser parental sacrifice, and one finds that the respective species are those marked by coarser feeding habits, which habits, evidently, render progressive parental sacrifice impossible. To the bees, flower-pollen is the only nitrogenous food, while the wasps appropriate largely animal matter instead. What are the resulting divergences in the general circumstances of life, in viability and evolution? We find that the bees are specially equipped for service—not only for usefulness in their own immediate interest, but also in the wider interest of the plant and animal world generally. They are of wide and general avail to life, than which there is no better way of avoiding fatal "over-specialisation"—the curse of legions of species, according to palæontology.

The bees are equipped for collecting and conveying (for purposes of cross-fertilisation of plants) pollen, and, hence, their anatomy and physiology differ from those of the wasps, which are adapted for predatory purposes.

The bees may be said to have emulated the spirit of the time, which is one of service in co-evolution. The wasps, on the contrary, adopted short-cut methods, those of glittering militarism, which is the bane of every race that adopts such a system.

Let us contrast the compensations, corresponding with the respective adaptations, in each case. When it comes to advantages for merely expedient purposes, the wasps may be said to be superior. Their mandibles, or biting jaws, are more prominent and stronger than those of the bees (wherefore many bees have to suffer). But the moment we take the long view, this is seen to be a disadvantage; for the strength of jaw was purchased at the expense of brain development, as the relative backwardness of domestic arrangements alone proves. In a general way, throughout the whole animal kingdom the development of the mouth and the anatomical structures connected with it depends upon the food and the methods of taking it. In general, it is not the maintenance, or enlargement, but rather the recession of the snout region which is the secret of progressive evolution, as was shown at some length in my "Symbiosis." The great development of the mouth parts generally occurs simultaneously with the progress of the animal in an insidious disease, terminating in "over-specialisation," in monstrosity and finally in extinction. Monstrous is as monstrous does! "Over-specialisation" is a mere term, not an explanation. At any rate, the orthodox have no explanation for the phenomenon, which, on my theory, briefly, is due to unsymbiotic feeding, *i.e.*, feeding that violates the principle *do ut des*. Is not the honey-bee marvellously "specialised," according to the above description? Yet, would any naturalist venture to speak in this connection of "over-specialisation," or would he feel justified in envisaging speedy extinction for the hive-bee? Scarcely, in view of the astounding vigour and industry displayed by them. And the reason why the honey-bees are felicitously specialised for survival is that they are "rightly" specialised, "rightly" adapted, namely, for service;

whereas those creatures which are adapted for merely expedient purposes, for theft and murder, are wrongly, or "mis"-adapted, and, hence, suffer the nemesis of "over-specialisation" and of consequent elimination.

Unlike the bees, the colonies of the wasps are annual only, such curtailed life being all that is vouchsafed to them on the inferior dietetic basis that is theirs.

The wasps have this in common with the cancer-cell, and with other predaceous entities: they are improvident. They do not store food, as do the bees, and as do the normal cells of our body. Nor would the animal matter, which they consume, lend itself particularly for protracted storage. Hence, too, the wasps are unable to provide for their young as adequately as the bees. Unless the weather is consistently fine, many incipient wasp colonies must perish, because of the inability of the mother to secure supplies. The life of the wasps is, for the same reason, precarious and much more at the mercy of circumstances than that of the bees. When sharp weather arrives, the workers drag out the remaining larvæ from their cells, killing them, as though to spare them the agony of slow starvation, after which they also fall victims of the cold nights of autumn. The homes of the wasps are thus the scenes of great tragedies, reminiscent of the cancer tragedy; whilst the same fatalities are largely avoided by the vegetarian bees. Add to all this that predatory creatures in Nature usually exhibit the self-same cannibalism which marks the cancer-cell, and we need no longer be in doubt about the inferiority which is theirs. Members of carnivorous species devour each other to a suicidal degree. The facts have been far too little collated to enable their full significance to be realised. Hence it is that all we may get from an orthodox biologist is an occasional hint at the "apparent" incongruity of carnivorism—it appears somewhat in the light of a lapse on the part of Nature, as one of them stated the other day, "whether it be indulged in by a protozoon or by a human being."

Evidently, on the long view, food either makes or mars the organism, according to its biological adequacy.

Unconsciously, food promotes this or that mode of organisation, according to its source, according to the way in which it is earned. To be able to appreciate the cumulative effects of food is to understand one half of evolution.

It is a remarkable fact that in the tropics, too, the colonies of the wasps die off annually, as though from physiological necessity. There is here no scarcity of food, nor reduction of temperature, and the usual excuse of failure does not apply. Evidently, the calamity is due to the ill-effects of "in-feeding" (carnivorous) habits; for what exceptions there are occur in a few cases where the wasps actually store honey, like the bees, and, where they, no doubt, subsist more purely on vegetable substances. But then there runs through the wasp tribe also, according to Wheeler, a tendency to become increasingly vegetarian.

It has recently appeared to the Aberdeen branch of the Workers' Educational Association that they might obtain some useful suggestions by being instructed in the Ways of Life as exhibited by plants and animals, and this has led to five lectures by five Aberdeen University professors, collected and published under the ægis of Prof. J. Arthur Thomson, the well-known zoologist and biological writer, under the title of "Ways of Living, Nature and Man," and dealing with "three chief ways of life—the individualist or independent, the parasitic, and the co-operative or social."

With three ways this publication indeed deals; but not in the manner which I would commend, despite the otherwise deservedly high standing of the authors. For, first of all, the chief lesson of evolution, as emerging from the study of the marked contrast between Symbiosis and parasitism, as between the results of "cross-feeding," on the one hand, and "in-feeding" on the other, is slurred over, and a comparatively superficial antithetic development is substituted for this, the main contrast. All that we get, apart from a collection of data, interesting enough in themselves, is the conclusion, which we might have entertained without need of a special inquiry into

Nature, that both solitary life and social life have their advantages and also their drawbacks. Here we meet with the usual special pleading in exculpation of criminal species, and it is plain that the authors are too deeply attached to their Darwinian repertory of catch-phrases, which will fit any and every condition, to strike out a new line of their own. A critical examination of that recently produced volume will show what is really amiss with orthodox biology. Let us see.

In his own contribution, Prof. Thomson has not proceeded very far before he is struck by the contrast shown by the grazing herds of cudchewers, showing very little competition among themselves, and the predatory animals given to solitariness and competitive ways. He poses the right question in this connection, and up to a point even answers it—"Do they not share the pasture amicably as long as it lasts? What a contrast this to the snarling of the hyænas, crowded around the carcase, or the jostling seen in many a shoal of fishes, where there is competition for every mouthful."

It is the symbiotic line of evolution which has produced the most highly-developed creatures and finally man himself, the Lord of Creation, the arbiter of all organic life, as against which the purely carnivorous line may boast of the wolf, the hyæna, the lion, and the tiger—outlaws which the evolutionary process is about to throw upon the rubbish heap. How, in the name of common-sense, can we be in doubt which is the superior line? Yet Prof. Thomson proclaims from the housetops that in nature predatory adaptation pays just as well as symbiotic. Such a challenge to common-sense and to moral and religious tradition is also a part of the Darwinian repertory. It helped to gain notoriety and also popularity amongst the get-on-at-any-price-fraternity, impatient of moral and religious sanctions or restraints, with results that we all have reason to deplore. Witness after witness is now coming forward to declare that through this means the ethical standards of conduct have been lowered, and that there has been a depreciation in the sense of moral values. "Nothing

matters," that is the spirit which has been fostered by Darwinism and the allied academic elements.

In support of his uncommon-sense, Prof. Thomson draws purely formal distinctions between "dependent" and "independent" creatures, as though dependence *per se* constituted a taint, which, of course, it does not at all, only illegitimate dependence constituting an evil. It is the repudiation of normal dependence by methods of brute force, as in carnivorism and plant-assassination, or by knavish dependence, as in parasitism, which constitutes the taint and the crime, however formally independent the organism otherwise may appear to be.

Whilst paying lip-service to Herbert Spencer's dictum that "self-sacrifice is no less primordial than self-perservation," Thomson feels a special call to break a lance for what he describes as "each for Himself." For this purpose he first throws overboard the most significant of all contrasts, namely, between solitary-cum-predatory adaptation, on the one hand, and the social-cum-restrained, *i.e.*, symbiotic, adaptation, on the other, by imposing the decree that the contrast in Nature is not ethical at all, but purely "social" (although, surely, the one should include the other!) The contrast, according to him, is merely between two (ethically nondescript) "divergent ways of living—each for itself or each for others as well."

There is only one legitimate way of assessing the true value of the principle "each for himself," as of that of association, and that is by finding a way of affixing the moral signs in each case, failing which we are at sea and bound to make haphazard and artificial estimates. Such procedure, however, is "verboten," according to our popular biologist. We are up against a Darwinian taboo. We may most learnedly "research" in this or that direction—to the ends of the earth, if we so desire—so long as we refrain from instituting an inquiry into the most vital of issues, the moral issue. *La recherche de la paternité est interdite*—so ran Napoleon's brutal code. Napoleon was in principle a Darwinist;

he hated scruples and preferred "social" to ethical considerations. Morality did not fit into his Gargantuan system; nor does the delicate plant of ethics fit into the scheme of Darwinism side by side with the monster of the metaphorical "struggle for existence."

The hand of the clock has certainly moved on, although at Aberdeen they are not yet aware of it. To-day we are entitled, in the light of new facts, to give place to or expand the self-sacrificing plea of Herbert Spencer. We must say that Symbiosis, and what it implies in altruistic qualities, is as primordial as the instinct for self-preservation, and, what is more, that the attainment of co-operation and of progress through co-operation is of the very essence of the evolutionary process. Self-preservation, likewise, becomes increasingly a matter of the co-operative preservation of others—unless, indeed, the organism persists selfishly in an abnormal and immoral career, involving evolutionary pathology. Proudly do our biologists boast (though this also curries favour) that they are "hardshell Darwinists." Their glory is their shame! Not willing to deal with values, they have to remain Darwinian, or, at least, something similar. When out to estimate success in evolution, should we not discriminate between transient and more permanent results, and for the same reason, take into consideration the divergent ways of living that led up to such results? No trace of such important issues are to be found in the book under examination. There is "mixology," instead.

For instance, the fact that there is frequently some amount of goodness left even in a carnivore, is made use of to exalt a carnivorous and solitary adaptation to the rank of a symbiotic, which is special pleading. The fact that an organism, by adopting the career of a thief, or that of a murderer, is gaining thereby some advantage, is too alluring to the biologists. "There is the profit," they say, and Nature is after "profits." What else could she be after in this mercantile world? But if we

take into account the whole compensations of the divergent ways to which I would call attention, there cannot be any doubt that the predatory creatures are inferior and that mere expediency has not the sanction of Nature. But, as I have already demonstrated, biologists take good care not to provide the whole catalogue of drawbacks incidental to the cherished and irresponsible predatory life. From Thomson we get no hint that carnivorism differs only in degree from parasitism, and that in thousands of cases carnivorism degenerates by easy transition into parasitism. Nor is the fact of the wide prevalence of cannibalism among carnivorous species mentioned at all, although this is a sure indication of degeneracy, of an entry on the road to Avernus. We get the advocacy that "the parental care of the solitary bees is not markedly inferior to that of the social species that live in wild colonies or in domesticated hives."

Some slight degree of superiority of the social species is even thus admitted, and we may say that the "little more" may easily amount to very much in the course of evolution. But the comparison is most unfairly drawn as an illustration of the contrasts that really exist and betray the tremendous difference of the respective ways of living.

The case of solitariness is unreasonably exalted by pleading the case of a cross-feeding species, where solitariness is least, and least typically, to be met with. The solitary bees which excel in parental sacrifice are at any rate cross-feeders, and may, hence, be regarded as approximating or nearest of kin to the state-forming bees. They are prospective state-formers, and are in many ways superior to those primitive solitary bees which are predatory hunters of other insects.

So far as the vast majority of solitary predatory insects are concerned, parental care is precluded in their case, since the mother does not survive reproduction or even see her offspring. What is the inhibition? Precisely the same factor which prevents storage of foods, which favours prodigality and waste, whether

amongst solitary or social species, to wit, predatoriness—such is the nemesis of depredation. Philosophically inclined biologists have been forced to speak of the nemesis of reproduction in this connection, and they have been obliged to admit that such nemesis is most acute amongst parasitic species. It needs but the further realisation that carnivorism is a kind of first step in parasitism, and we shall arrive at the conclusion that the respective nemesis represents a penalisation of ways of living which are ethically and physiologically wrong, and at the same time economically and socially unsound.

The ghastly forms of reproductive nemesis to be met with among parasites have often been described, and allusions to such can be found in my various writings on the subject.

The learned Aberdeen professor tells us, most assuringly, that the pair of golden eagles in their lonely retreat are as devoted parents as the rooks in the crowded rookery. Possibly there is not much to choose between the two ; but this does not take one iota away from the fact that it makes all the difference whether a species lives by the predatory in-feeding, or by the symbiotic cross-feeding principle.

What is omitted is that the drawbacks of the eagle's predatoriness are such as to extinguish all brotherly and sisterly feeling, and the stronger of the two eaglets in the nest usually kills and devours the weaker- clear evidence of evil communications, the analogies of those transmitted simultaneously to the very cells of the body, until, in some cases, we may get malignant disease. The ethics of family life we must assume to be in course of decay in predatory species. In the case of the predatory and parasitic cuckoo, the ethically wrong and socially unsound adaptation of this highly insectivorous and unsocial bird ends in general criminality, as is well known. The female shirks the brooding sacrifice, and Professor Thomson would scarcely care to hold her up as typifying the fine parental care of solitary species !

With regard to parasitism, Professor Thomson tells us that what most deeply marks it is the attainment of food and shelter with a minimum of individual struggle, adding that its frequent stigma is some degree of reduction and degeneracy.

Apparently, then, every organism should "struggle" (metaphorically), and, if so, there is an "ought" which cannot be violated with impunity—or else what is the sense of the word "stigma," or of the actual stigmatisation which universally does occur upon violation of the bio-moral law of service? Why not be more precise? Is it not the very object of science to be precise? Why not leave metaphorical language to poets and theologians, its legitimate users? What is this "ought," the violation of which leads to stigmatisation? Should an organism spend its time religiously exercising all its parts, as in the case of an athlete, in order to escape stigmas and reductions, the accumulation of which might reduce it to nullity, undoing all the work of evolution, or in better fashion, should it not be active in some useful work, giving free scope to a liberal exercise of the parts? The words "Use and disuse" are generally invoked in these matters, as though they had not an ethical and economical import.

If part of an organism atrophies from disuse it means that it no longer receives any remuneration from the body physiological, just as a profession in the political state usually ceases to be subsidised by the people if it becomes useless.

Service and co-operation alone can ensure a right to live, a right to remuneration, be it in the physiological, the biological, or the political sphere. But we have seen already that domestic impoverishment ensues on a species becoming predatory—which stands to reason, for the principle on which it lives is the opposite of the storing and wealth-begetting principle. A predatory creature only wishes to appropriate by stealth or by force the savings, the storage, the results of others, so as not to have to labour itself, and, in so doing, becomes itself impoverished. This it is which involves

what I call nemesis and stigmatisation, consequent upon a shirking of bio-social and bio-economic duties—duties imposed by the necessity of maintaining organic " civilisation " as a going concern.

If all birds behaved like the cuckoo, bird life would soon come to an end. If all organisms were to turn parasitic, the whole structure of organic life would collapse, and the epitaph might be—ruination from lack of moral fibre and concomitant absence of a legitimate moral and economic basis of life.

The true definition of parasitism is that it is marked by one-sided exploitation of organism by organism, which produces distress and reacts disastrously upon the parasite itself.

Prof. Thomson lets off his special clients, the parasites, too lightly by his far too casual reference to a vague sort of stigma ; and, indeed, he tries deftly to transfer the idea of nemesis to the opposite, the good mode of life, thereby unduly approximating the two in his customary " mixology " manner. With his usual ingenuity in these matters, he selects instances of the social life, presenting an abuse of the social principle in the parasitic direction. Says he : " What most deeply marks the co-operative (social, communal, gregarious, or partnership) regime is some measure of self-subordination on the part of the co-operators [which must involve ethics] and some alleviation of the individual's struggle for existence [only a way of saying that it is better to work with others than against them]. Its nemesis may be a loss of individual allroundness and a sheltering of types that would be eliminated in individualistic conditions."

This is sheer casuistry. The term nemesis, wrongfully withheld in the case of the admitted curtailment of the parasite, is here for the first time introduced to apply to a type, the co-operative, least deserving of ethical blame, except when, by way of backsliding, it travels towards the opposite, the parasitic, pole of life. Prof. Thomson pits the best that solitariness has to boast of against the worst he can find in sociality, and

then tells us triumphantly it is six of one to half-a-dozen of the other. Why take on the burdens of the social life, with its attendant risks if, to remain predatory and solitary, in Thomson's words, "certainly pays equally well"?

Everything mortal is frail and apt to lapse into abuse of some fundamental principle. But the chief abuse is that of the parasite in violating a principle never mentioned by Prof. Thomson, yet by far the most important from the very dawn of life, namely that of *do ut des.*

Compared with such abuse, the "alleviation of the individual struggle for existence" in the co-operative life is a very small matter. Some degree of self-sufficient and actively individualistic life, moreover, is compatible also with life in a social state, although it is possible that the insects do not show too well in that respect. But we may have much still to learn with regard to the insects.

Despite much progress in some directions, the insects seem to have lagged behind in others. Their system of obtaining supply of oxygen by means of minute air channels, instead of by evolving an internal organ of respiration, such as a lung, is an indication of organic poverty. It means small oxidasive power. Such a creature is not in a position to render significant services in muscular work and in respiration to plants, and can thus do but little to further the main scheme, the co-evolution between plants and animals, as it is the privilege and distinction of the aristocracy of life to do. Man, through his possession of hæmoglobin—the result of primordial symbiotic association with plant life—is far better off than the insect, being much more widely adapted for partnership with plants, which supply the chlorophyll, the source of our blood pigment, as also the oxygen, the vitamins, and other indispensable substances. Hence, the insect is antecedently debarred from doing as well as we do in most matters; and we have no need to fear that such imperfections as, from our point of view, frequently mar the social institutions

of the insects, will easily be translated to our fundamentally much more exalted position ; such or similar imperfections more often than not, would not square at all. To find an insect in the ludicrous adaptation of a honey-pot need not deter us from passing a measure of social legislation in alleviation of some undue social inequality, if to our own human experience the measure is calculated to benefit the community. That the life of ease " is one that drifts," that life " is not as idle ore," is, of course, the general lesson to be drawn from all life whereever we find it.

That even the lowly insects, along their own lines of evolution, have been able to do remarkably well, particularly where they subsist on the universally beneficial basis of symbiotic cross-feeding, is another lesson well worth the learning.

The factors of " Natural Selection," according to Darwin, are competition for food, competition with one's own kind, grappling with foes or parasites, the incidence of diseases, the inclemency of the seasons, and such like. Now, in as much as life in a social state tends to alleviate many hardships of nature—obviously it does not remove all the dangers, and leaves ample scope for ever new and special efforts—it is calculated to aid the evolution of the species, just as the advance of civilisation among men, ensuring leisure and margins for endeavours in new directions, is calculated to produce a better and more advanced race of men. It is to such reliefs, plus the advantages incidental upon an implied co-incident improvement in biological association (in Symbiosis), that we must look for the discovery of the positive factors of evolution. These factors are, as I have often shown, of a socio-physiological order, and the very term indicates that the progressive life entails not merely alleviations, but many new and arduous duties. This being the case, and life being frail, we must make the fullest allowance for a *corruptio optimi pessima*, rather than jump to the conclusion that the social life is no better than the solitary. We must not misappreciate power, though it be frequently abused ;

and we must certainly try to understand how power is engendered and best maintained. In the past, just as in the case of man, many social insects eventually found that the best method of defence is offence and their enemies were attacked before they could reach the nest. The *qui vis pacem para bellum* amongst insects, as amongst men, thus proved a first step to the organisation of marauding and plundering expeditions and the development of aggressive warfare. None the less it should not be overlooked that in all such societies it is in the first place from the arts and crafts of the honest and humble industrial life that the power for war is developed.

It is again evident from the following that Prof. Thomson wrongly contrasts the advantages of the solitary life with the abuses of the social, which is misleading. Says he : " The advantages of the " each for himself " mode of life are that it fosters all-roundness of development and sturdy vigour. The disadvantages are that the struggle for existence may be intensified to the unendurable uttermost—which spells extinction—that the mastery of the environment is more limited, and that there are fewer opportunities for cultivating the integrative kin-sympathies with flourish in a social milieu. On the other hand, the co-operative, gregarious, social mode of life, which certainly makes for stability, achievement, social sentiment, and sometimes external heritage, as in the ant-hill and the beaver-village, is apt to over-subordinate the individual and to throw a shield over variations that were sometimes better dead. It is an extraordinary fact that some ant-species, that can neither collect food nor eat it of themselves, are kept alive by their slaves ! "

Perhaps Prof. Thomson wished to convey a slight warning in regard to those who want to stampede us into socialism. There is, as an admirer of his recently stated, such ease and simplicity of style and treatment in his writings as to give an appearance of obviousness. I am afraid, however, though it be quite true that no one has contributed more to popular education in the

natural sciences than he has, the very perfection of Prof. Thomson's writings acts as a double-edged sword, instilling not a little sophistry into the public mind whilst otherwise enriching and entertaining it. The reviewers who are profuse with laudations of such a passage, of course, are, most of them, men who have themselves been brought up on the petty repertory of Darwinian catch-phrases.

They swallow quite uncritically the time-honoured dogmas that their biological bigwigs customarily proclaim. If their favoured catch-phrases are clothed in brilliant style, and if the effect of the whole be to favour re-action and stagnancy in the social sphere, they become rhapsodical in their praise. If we want to know what it is that intensifies the " struggle for existence " to the unendurable uttermost and leads to extinction, with a loss of " mastery of environment," we must institute an inquiry into those feeding habits which inevitably lead to intense and cruel competition, to internecine warfare, to a multiplicity of pathological developments and to a " divorce from Symbiosis "—a socio-physiological study, of which we get no inkling in Darwinism, or in Thomsonism, which have only catch-phrases to offer.

One might think, on reading Thomson's passage, that the solitary life is the guarantee against parasitism, whereas, in reality, almost the opposite is the case; for solitariness is usually represented by the predaceous species, which may be said at all times to stand with one foot, if not with two or three, in the parasitic camp. It makes no difference that Prof. Thomson may plead that what he has in mind merely concerns the " independent," not the parasitic life. I grant that a carnivorous species, which still fends for itself, is superior to a rank parasite, incapable of even a movement without the help of its host, but the difference between the two is only one of degree so far as the underlying principle of life is concerned, and there is no such thing as " independence " in organic life, where there is only legitimate dependence and illegitimate dependence, a most vital distinction, slurred over by Prof. Thomson

with all his brilliancy of style, his great and indisputable erudition, his mastery of language and of the biological stock-in-trade phrases.

That a semi-degenerate organism, such as a carnivore, fending for itself, is superior to a totally degenerate organism, such as an obligatory parasite, incapable of fending for itself—is all we may say. The highly degenerate ant-species, which Prof. Thomson uses as representatives of the social life, should not be dragged in at all in illustration of the contrast between the social and the solitary life. They are the species deeply lapsed in predatoriness, quite divorced from Symbiosis, showing what the social life should *not* be, and normally is not They have long repudiated the very principle upon which the social life fundamentally rests.

Let us repudiate the wrong, the carnivorous and parasitic principles of life! Let us seek instead those principles that lead, in Thomson's words, to the cultivation of integrative kin-sympathies, to stability, achievement, social sentiment, and external heritage; let us apply our richest and fullest experience of human and organic life to the task of preventing and of remedying the defect of the social life rather than declare that because there is much iniquity in Nature, it is normal and incumbent upon us to be iniquitous also. We may thus become more eugenic in the future, more stringent in our demands of social, ethical, and physiological rectitude. A kind of scientific puritanism may save us. Truly has it been said that disease is often but a synonym for sin. But, much though I defend (though differently from Thomson) the idea that most illness is ultimately due to disharmony with general philosophic and biological laws, I do not for a moment think that the prescription of "Natural Selection"—a kind of "devil-take-the-hindmost"—will at all avail us. "Give them Natural Selection," is the parrot-cry of the reactionaries, the bogey of the professor loth to tackle the sociality and the ethics of organic life. Rather do I believe in the counsel of our seers, such as Shelley, for instance—"the

abolition of personal slavery is the basis of the highest political hope that it can enter into the mind of man to conceive," or Ruskin—" It is impossible to conclude of any given mass of acquired wealth merely by the fact of its existence, whether it signifies good or evil to the nation in the midst of which it exists. Its real value depends on the moral sign attached to it just as sternly as that of a mathematical quantity depends on the algebraical sign attached to it. . . . Luxury is indeed possible in the future—innocent and exquisite ; luxury for all, and by the help of all ; but luxury at present can only be enjoyed by the ignorant ; the cruelest man living could not sit at his feast unless he sat blindfold."

Let me here state that I do not stand alone in my views that there is but a difference of degree between carnivorism and parasitism, and that it is the fact of one-sided exploitation that constitutes the crime. In their book on " Parasitism, Organic and Social," Massart and Vandervelde (joint authors) insist that Nature shows little in the way of fixed landmarks or dividing lines. They speak of the " ignoble " ways of the plundering robber-gulls, flying in the wake of the gregarious sea-mews and stealing from them their catch of fish.

There seems to be remarkably little difference, they say, between the parasitism of these robber-gulls and that of parasitic crustaceans which lodge in the mouths of fishes and help themselves to the minute organisms which their hosts have caught for their own consumption. Evidently it is the principle of the thing that matters most.

We must be on our guard against parasitism of every sort. Whether it be that of individuals or of whole classes, we must try to defeat it. But individualism, carried to the extent of predatoriness, is certainly not the remedy, for it only leads to the same malady through another extreme. The cardinal lesson from Nature is that, above all, we should guard against physiological and biological parasitism. In so doing, we should remove the very temptation to social para-

sitism by reducing the tiger in man and giving brotherliness a chance, whatever our political system my happen to be. It is the type of the man which in the end determines the political system and the benificence or otherwise of a particular system, although the system, of course, is an important factor in determining the man.

Now it seems to me that to speak of a balanced character in a solitary predatory creature amounts to a contradiction in terms. I fail to see much "all-roundness of development" in a feline creature, for instance, or in a shark, despite their fierceness and bodily strength—which nevertheless are not identical with true fitness for permanent survival. I fail to see how the "each for himself" of a tiger, or of a shark, can have any attractions for us. Only one lesson do such adaptations teach, to my mind, namely—how *not* to do the same in life. The ready use of force is, to my mind, the very way to inhibit and to defeat the chances of all-roundness of character and of intellect, leading, as it does, to losses of "mastery of environment" far greater than our guide from Aberdeen would lead us to suppose. Successful organisms modify the environment by their patient industry in a sense favourable to themselves and to the progress of "organic civilisation" generally, which is more than could be claimed for lions and tigers, which establish no useful linkages and which live in constant danger, through increasing fastidiousness and excessive extermination of "prey" or "hosts," of becoming ever more limited in themselves and in environmental resources.

Let us take a concrete instance of a symbiotic, cross-feeding, social, higher animal, improving its environment, tending towards life in the widest sense, and illustrating by comparison that a solitary predatory creature cannot come near it at all.

Let us also take the case of the beaver, referred to, though far too slightly, by Prof. Thomson, who prefers instead to dwell on the charms of the elusive badger, a nocturnal, frugo-carnivorous, or omnivorous beast.

The beaver, like the ant and the earthworm, has had

a considerable share in the moulding of the face of the earth. The constructive art, displayed in the beaver's wonderful system of dams, canals, and ledges, which has profoundly modified the landscape in hundreds of swampy valleys in Canada, Newfoundland, and the Northern States, has been the admiration of all observers. Mr. A. R. Dugmore has written a book on the beaver's methods, in which it is shown that the labours of this rodent, unlike those of its cousin, the rat, are of positive value to man. The probability is that for thousands of years the beaver colonies with their tree-built dams have been preparing the surface of the land for agriculture. The "beaver-meadows," composing some of the most fertile lands in North America, form level terraces in the river valleys on the site of the pools held up by ancient dams. Autumn by autumn the soil and leaves borne down by the stream were caught and deposited in the dam-pool, until a wide floor of humus and alluvium replaced the rough and scrubby margins of the primeval stream. According to Mr. Dugmore, animal intelligence is largely shown by the power to seize the suggestions of accident, and the beaver gradually developed the casual barrier of dead trunks and boughs into the large, elaborate, and carefully-tended system of dams and canals, which Mr. Dugmore so attractively describes. Beavers' canals are made for transporting wood more easily than by land, and some of them these are more than 300 yards long. Says Mr. Dugmore: "Their comprehension of the entire problem of water supply and control is so altogether wonderful as to be almost incredible, and even so, some people claim that they do not reason."

In Colorado a plan has been developed and put into operation, whereby beavers are taken from a section of the State where they are plentiful, and transplanted, as it were, to other sections where their services are more essential. A case is recorded where a rancher, who had only enough water to irrigate a small plot before he imported beavers, now has sufficient water to cultivate forty acres successfully.

How do these industrious animals live? They are vegetarians, deriving food substances from the spare-products of the plant. In the summer they live on roots, berries, leaves, and aquatic plants, whilst in the winter they eat the bark of the trees they cut down during the autumn They would seem to prefer the bark of deciduous trees, such as the aspen and willow, trees which are of little economic value. Pine they never attack. Hence they tend to rid the country of weed trees and are of additional value on that account.

We may conclude that, given the right feeding basis, good results will spring up in all directions, of their own accord, as it were. Will educationalists please note that there is not a more important lesson to be gleaned in the whole realm of science.

Whilst on this subject, a word may also be said for the cross-feeding rodents in general in their capacity as forest-planters. Blessings are prophesied for the man who makes two blades of grass grow where one grew before. Hence blessed also must be those creatures which contribute to the growth of forests. Few people realise that the regeneration of forests is largely due to rodents. These are in the habit of storing (burying) nuts and cones, many of which they do not consume, thus leading to the distribution of seeds in the most appropriate localities. In this way the silent benefits conferred by these furred forest planters far outweigh any damage they may cause. The pine squirrel is very abundant in some American forests and has the habit of making certain of food for a hard winter by storing the seeds and cones of the forest trees. Sometimes forty bushels of white pine cones have been found in a single squirrel cache. And the squirrel knows how to cut the finest cones better than any forester. Many more animals and birds than hitherto imagined, whilst helping themselves to the wild fruits that the forest or the countryside has to offer them, assist in the reproduction and the distribution of the respective trees or shrubs, as the case may be.

The seeds of yew and guelder-rose and mountain ash are scattered by birds on rocks or ruins which few plants would otherwise reach.

Acorns and walnuts are carried by rooks to hills and sometimes dropped there before they are eaten. Plant helps bird and bird helps plant. That is the Golden Rule of Life. Benefit is the end of Nature, but for every benefit obtained a toll is levied. The non-reciprocal is the unnatural, the immoral, life. So far from producing such benefits as I have just portrayed, such a course of life leads to satanic effects, satanic "complexes," involving limitation and lopsidedness, and not "all-roundness" at all.

Nothing but deterioration of character resulted from the conversion of the Kea, the New Zealand parrot, into a bird of prey. Driven into the mountains by man, that once social and amiable bird became a sheep killer, instead of remaining a cross-feeder, and as a result of this its character underwent a change in the direction of ferocity, to so considerable an extent that the Government has put a price on its head.

Other cases of deterioration of character have from time to time been reported following on a similar change of diet.

In speaking of the tax that man has to pay for living in a social state, Prof. Thomson avers that he is merely protesting that man has something to learn from the unsociable gorilla as well as from the troop of monkeys, from the otter as well as from the wasp, from the eagle as well as from the rook. He would have the best of two worlds, and commends a combination of the virtues of "both policies."

But has not man paid dearly enough for listening, early in his career, to the serpent? In what way shall we copy the savage gorilla? It is true, he is at least a cross-feeder, which shows that savage strength is to be had without resort to carnivorism, although this is not at all what Thomson wishes to convey. But the gorilla has developed the pernicious habit of destroying trees wholesale, has beoome a veritable plant-assassin,

and, hence, his brutal strength has availed him naught ; for, by way of nemesis, he has become monstrous and acromegalic—the usual penalty paid by plant-assassins for their lack of moderation and of forbearance towards life. He has nothing to show from which man has anything profitable to learn, nor have the other predatory creatures, whose "policies," our Aberdeen sage would fain have us copy. Sooner than be led by this locally manufactured Natural History, I would advise the workers of Aberdeen and neighbourhood to turn to the philosophy of the old Bible on these matters, with its insistence on universal righteousness.

It has not escaped Prof. Thomson that, in making comparisons of "policies," one is in danger of drawing out cases so as to show that one way is better than another, *i.e.*, somewhat arbitrarily. Hence, lest he should be found guilty of arbitrariness, he tries to forestall the criticism by resort to philosophy thus : "It is when we take a broad survey that we become convinced of the open secret that *both ways are best.* Towards given ends, at particular times, in certain circumstances, man should learn from the eagle ; towards other ends, at other times, and in other circumstances, he should learn from the rook. . . . Each is a good solution, according to ends, times, and circumstances. Both ways are best."

This is the teaching of Dr. Pangloss over again—whatever is is best—the idolatry of expediency, the celebrated philosophy upon which Darwinism rests.

We are recommended to shape our course of life as opportunists, according to this expediency, irrespective of all moral considerations. But what about rank parasitism ? Here our guide feels less certain in applying his Panglossian philosophy. Having told us that the virtues and the defects of the social and the predatory life nearly balance each other, he feels that parasitism may perhaps be a little exceptional, and he surmises that perhaps with regard to "thorough-going parasitism" it cannot quite be said that its virtues and defects balance those of the ordinary social life in

human and in sub-human societies. He feels that parasitism—although representing the "fittest," according to the cherished Darwinism—is not quite so easy of defence, but he must perforce remain half-hearted in its condemnation, since a more complete condemnation would entail also that of carnivorism, the half-way house, and this is more than Thomson would care to undertake in the present state of science and of society. Orthodox biology is written, as I have often said, to suit the perverted digestion of modern society.

Within the prescribed sphere of current biology, Prof. Thomson can occasionally be quite broad-minded, as I have often testified. His great knowledge of facts has convinced him that one can easily prove too much by confining comparisons to particular types of animal in a district which may not give a wide enough survey. With us, for instance, the extension of agricultural land has greatly diminished the chances of "Wild Life" among the larger creatures. If we compare merely the types left amongst us, we may, to the detriment of our comparison, be leaving out of the reckoning many of the finest types to be found elsewhere.

Thus Prof. Thomson would not leave out of account "the cleverness and loquacity of monkeys, the wisdom of elephants, the intelligence and adventurousness of wild horses, the defence of the young amongst gregarious ruminants, the kin-sympathy of the viscachas, and so on."

The question is, has Prof. Thomson sufficiently assessed the high value of the virtues here enumerated? In my opinion he has not. Another consideration arises from his remarks, and it is this—for any valid contrasts to be drawn we must take long range views, such as I have presented, drawn from a whole order, or class, or phylum, and instancing *inter alia* how even in the "kingdoms" as a whole the marvellous adherence to cross-feeding, shown in either "kingdom," has on balance been very markedly superior to the policy of in-feeding.

The highest and most important plants have remained cross-feeders, and the highest and most important of the animals such as man and the anthropoids, clearly owe their chief patrimony to the same principle of life. The verdict of evolution is entirely against the in-feeding way of life. Nature abhors perpetual in-feeding.

Prof. Thomson has even come to see, what I have often pointed out in other words, that we are not entitled to credit the finer types of solitary "self-sufficient" individualistic types with engendering, *qua* solitary, all the virtues they possess; such types often represent merely "well-endowed survivors" in difficult conditions. That is to say, their good qualities date back to ancestors whose original prosperity and power of inheritance was due to quite different ways of life from those now shown by their modern representatives. As Thomson finely says: "Their fineness is not altogether due to their individualistic ways. The other side of it is that they are able to stand alone, four-square to the winds, because of their original virtues of body and brain."

The good qualities of many predatory creatures thus go back to the days of a cross-feeding ancestry, and it is to many such residual good qualities that Prof. Thomson unwittingly calls attention in trying to exalt the predatory principle of life beyond its merits.

It is not until he comes to discuss "the origin of the two ways of living" that Prof. Thomson feels constrained to admit that nutrition is a determining factor. Like the rest of his colleagues, he shuts his eyes and gives no place to the ethics and bio-economics of food, although nutrition involves appropriation and, concomitantly, the vital question of the legitimacy or otherwise of gaining sustenance. Again he reiterates the naïve view that a murderous way of maintaining life is on a par with a harmless one, and that one way is as much sanctioned by Nature as another, as though species in Nature were above good and evil, as though interdependence of life did not exist, as though interdependence did not involve the necessity of laws of

intercourse. According to him, it "pays" to do a little murdering and, therefore, this is normal.

Always it is the immediate "profit" that is made important and thought to pay, although it be a profit that in the end blesseth not. Thus we get the following: "When an animal is a fisher or a hunter it is more likely to follow the "each for himself" policy. Much depends on the nature of the food. It is easier for the honey-sucking bees to be social than it would be for the insect-snaring or the insect-hunting spiders."

Though much of this seems evident, yet one might as well say that a crook finds it best to keep himself a little from society and that it is on the whole easier for a saint to live without a dagger than for a highwayman to do so. In so many words, of course, the professor here admits that the chances of social life (and of progressive evolution) are greater amongst cross-feeders than amongst in-feeders. On another occasion, Prof. Thomson speaks of "the rewards that come to those organisms that covet the best gifts," which is indicative of a belief, which I share with him, that organisms have a certain choice of roads. If it be granted that much depends on the nature of the food, much, therefore, must be held to depend on the organism electing to be either a cross-feeder or an in-feeder. Such considerations, however, are slurred over by our professionals. Although (falsely) claiming to be "authorities" they do not see at all clearly with regard to nutrition, any more than with regard to "profits," or with regard to organic sociality generally. It has to be seen that much more than our erudite but naïve professors think *does* depend upon nutrition, and particularly upon the ethics of nutrition, and a totally different picture of the two pathways of life emerges from that presented to us. It is also clear that the moral law universally overrides mere expediency.

I have likewise to controvert even Prof. Thomson's statement that solitary types are characteristic of the more strenuous surroundings—surroundings where the

environment is inhospitable and the fare none too generous.

In the arctic regions there are the vegetarian and gregarious reindeer, feeding on lichens—themselves symbols of the social life—and we have the musk-ox of Northern Greenland, an animal of pronounced vegetarian tastes. Both are holding their own in barren and otherwise inhospitable wastes to the astonishment of not a few who know the facts.

I have laid stress on this, as also on many previous occasions, e.g., the striking contrast between the transient summer community of the wasp and the permanent community of the hive-bee, as illustrating the superiority of the cross-feeding over the in-feeding principle. To Prof. Thomson, the contrast indicates no more than the "survival value of thrift." But it is surely no coincidence that those animals which live in close symbiotic alliance with the plant have imparted to them an instinct for thriftiness, whilst those which have become divorced for Symbiosis—the favourites of Prof. Thomson —show themselves bare of that essential quality. The difference between the cross-feeding and the in-feeding paths of life is as vast as is that, in Ruskin's words, between the service of Wisdom, the Lady of Health—Madonna della Salute—and the service of Death, the Lord of Waste, and of eternal emptiness So long as biologists ignore, or camouflage, this issue, they will not be able to give us much more than the "nightview" of things, despite their protestations to the contrary, despite their fine phrases by which they seek to hide the gaps in their system.

My writings and writings such as mine have doubtless convinced our Aberdeen sage that there *is* a "dayview"; but he might not be in respectable company if he admitted it. Better instead to offer a little tribute to virtue in general, which is less committal and "pays" better.

This is how he pleads by way of displaying catholicity of taste: "Although the finer animal societies probably started with well-endowed animals, it can hardly be

doubted that the social inter-relations would favour the advance of intelligence and kindly sympathy. How intelligent the social rooks, cranes, and parrots; the beavers, the viscachas, the wolves, the wild horses; what repertories of ready-made efficiencies in the instinctive ants and termites, wasps and bees." With practically insignificant exceptions, the types here mentioned are cross-feeders; nor have in-feeders anything to boast of that could for a moment stand in comparison with them. The wolves have an intelligence of a sort, but not the one that really counts in social advance, whilst, so far as kindly sympathy is concerned, they are hopelessly out of the running and had far better not be cited at all by Prof. Thomson.

The rooks are omnivorous, but as I have already instanced, yet they distinguish themselves as dispersers of plant seeds and are thus not without symbiotic virtue. The wasps are partly carnivorous, and, hence, also, as I have shown, *pro tanto* inferior to the strictly vegetarian bees. Let there be no mistake about it, the "well-endowed" animals with which "the finer animal societies probably started" did not owe their original virtue to any "in-feeding" propensities, but, on the contrary, to what cross-feeding there was amongst them. If they were not originally "social," in the narrower specific sense, they were at any rate social in the wider, co-evolutive, sense; that is to say, they were in symbiotic association with their bio-economic partners, the plants, which alone could have afforded the wherewithal for fruitful endowment, as anyone can see who will examine what I have already written on the biochemistry of evolution. One might almost think, on reading Prof. Thomson's lines, that he wishes to suggest that the real endowment of the socially successful species dates back to the supposedly nutritious fare of an in-feeding ancestry. The argument should be reversed; the chances are that the endowment of wolves, for instance, goes back to an at one time cross-feeding ancestry, seeing, in particular, that the common ancestors of the carnivores, the Creodonts, approximate to the

frugo-carnivorous modern species of the carnivora rather than to the purely flesh-eating species.

The erudite professor evidently feels that there is some incongruity in his reasoning, and as he does not wish, for reasons of his own, to adopt my terminology, he introduces the word "virtue" as a substitute for cross-feeding, whilst shrouding the happy idea with all manner of customary jargon and verbiage. Thus does he hedge: "It may be thought that this is arguing in a circle. With one breath we say that plastic and sympathetic animals make societies, and then with another we say that societies make animals clever and kindly. But we believe that it is just in such virtuous circles that evolution has worked. Well-endowed animals send out social tendrils, and the incipient society forms a sieve in which variations in the direction of sociality are preserved, while variations in the direction of the anti-social are winnowed out, and cast as rubbish to the void."

Instead of which I should simply say—and increasing simplicity is usually a mark of progress in science—that symbiotic cross-feeders are *ipso facto* in due relation with the world of life and thereby best qualified to enter into fruitful, sympathetic and intelligent social intercourse of the most varied kinds. Organisation and socialisation themselves imply constant elimination of that which hampers their economic working; wherefore it is, too, that social species are not, as Prof. Thomson would almost have us believe, antecedently worse off than the solitary, allowance being made for occasional abuse of the social principle. If you have but a minimum of social principle then, of course, you cannot go to great abuse in that direction; but it is fairly evident that with greater aptitude for the social life there usually goes an enhanced ability for dealing with, and remedying, abuse, and even in this particular there are subtler and more constant lessons impressed upon the social organism than upon the solitary.

Thomson allows virtue to come in by a side-door only. There is really no place for her in the official repertory;

but she is still a very fair maiden, Darwinism notwithstanding, and her admirers are still sufficiently numerous to make it worth while being seen flirting with her on occasion. The notion, however, which would lend some real foundation to the idea of virtue in biology, namely, that plastic and sympathetic organisms are those which let other good organisms have a vital interest in their own existence, is evidently quite foreign to the councillor from Aberdeen. Were it not so, he could perhaps tell us what it is that constitutes vice in biology ? Apparently he would confine the seamy side to the rare case of over-subordination of the individual as in the honey-pot ants.

The introduction of the idea of morality into biology on my part has led to an almost wholesale condemnation of my writings by professional biologists, who expressed nothing but contempt for the idea.

On this matter, however, Prof. Thomson is evidently wishing to range himself by the side of the angels. Says he : " Social or co-operative life is essentially marked, as we have said, by some measure of self-subordination ; and this is one of the roots of morals. There is much of this self-subordination in parental care, especially on the mother's part, and the solitary, self-sufficient animal may have strongly flowing springs of good conduct, but there is something subtler, though not deeper, in corporate life. The social animal has to habituate itself to work in a team ; it is one of the greatest of moral lessons to learn to play the game. In animal communities there is a powerful social restraint on individual impulse."

If this be a tribute to the social life, it is also, contrary to what we are given to understand by Prof. Thomson, essentially a tribute to symbiotic cross-feeding. This realisation of Symbiosis is, I believe, the cardinal lesson we learn from evolution.

Some day, no doubt, the idea will dawn upon Prof. Thomson that a murderous creature is one which has in the first place thrown morality to the winds, thus being *ipso facto* debarred from forming a fruitful community.

Then, too, he will abandon his present view of evolution, summed up thus: Our theory is essentially the same as that expressed in the familiar [though not very deep or worthy] saying that 'Nothing succeeds like success'"; for that success may be only ephemeral.

It is part of my object to show how biology has miscarried, and it may be helpful towards a saner interpretation to examine into the expositions of Prof. Thomson's collaborators, who are seeking to compare the ways of life in nature with those of man.

Prof. P. Geddes, who has written a special "Envoy" to the book, tells us that these collaborators are "investigators amid the world-infinitudes of life, still so little charted." One of them, whose contribution on plant physiology is next to be considered, is Dr. Maggregor Skene, who, according to Geddes, brings his exposition up to the socially suggestive conclusion that though the green plant is the most independent of living things, "its life is yet not capable of being so individualistic as that of many animals; but has inter-relations of the utmost intricacy as well as comprehensiveness, as are being gradually unravelled."

Let us take Dr. Skene's own statement with regard to the inter-dependence of plant and animal life. Says he, "Only a humble-bee has a tongue long enough to reach the nectar of the red clover, and only the humble-bee can carry out pollination. The inside of a monkshood is an exact cast of the humble-bee's body, and the distribution of the monkshood is limited by the distribution of the humble-bees. The showy flower is, in fact, a structure which has no meaning except in relation to insect life. The flower, in the ordinary sense of the word, has been evolved in relation to insects and can function only with the help of insects. There are many flowers which are able to effect their own pollination if insect visits fail. But this does not affect the broad truth that flowers and insects go together, and that in this respect the flowering plant is dependent on another organism."

That plants exhibit a corporate life amongst them-

selves is also attested to by the same investigator, who states : " If birds of a feather flock together, plants of the same, and of very different, foliage grow together. The integration of the community may fall very low, even to zero, but, from the one extreme of the desert, to the other of the tropical rain forest, we might trace a whole series of connecting links. Communal life is the norm."

It is thus evident that inter-dependence of life is increasingly coming to the fore. Well may we distrust those who would dissuade us from a belief in the existence of definite economic and bio-social laws, regulating inter-dependence, and conjure up instead the vague " struggle for existence." " It is no wonder," says Prof. Geddes in his appreciation of inter-dependence, " that some of us organic evolutionists are also feeling compelled to question our old fundamentalisms anew, and so to begin searching towards what we may find of ' soul of goodness in things evil.' "

Why not begin by duly discriminating between " good and evil," which it has become the fashion to avoid ? None of the collaborators, despite the superlative praise bestowed upon them by Prof. Geddes, has made such discrimination, as the consideration of Dr. Skene's second contribution, on " Parasitic Plants," will show. It is replete with the objectionable old Darwinian " fundamentalism," as is here to be demonstrated.

There is a plant which in olden days was widely used by priests to instil awe and reverence into their followers —the mistletoe. This curiosity amongst plants at early times arrested the attention and struck the imagination ; and it was regarded with awe as an object of the supernatural. In some instances it was believed to be an instrument of doom, not because it was small and weak, but because it was a very peculiar plant, a magic spray never striking roots in honest soil, but springing in great bosky clumps from the branch of some tree, even the sacred oak, and green in winter when the tree was bare.

It is probably with an eye to the mysterious, which, as

in olden days, spells conviction, that Dr. Skene has fixed upon the mistletoe as illustrating parasitism, although, according to his own showing, this plant is far from being a thorough-going parasite, being, indeed, only partially parasitic. What we get, therefore, is a study of some evil, often connected with the good rather than "the soul of goodness in things evil," a totally different matter. Let us infer from Dr. Skene's own description that the mistletoe should not be quoted as a representative of parasitism. This is what he tells us: "From the host plant it takes only salts and water. Its leaves and branches, and even the internal outgrowths, are green, and, so far as we know, function normally in building up organic matter; to this extent the parasite is independent of its host."

The mistletoe is evidently an epiphyte which has lapsed into some slight degree of parasitism. Apart from parasitic it shows many symbiotic traits. Its photosynthesis, implying industry and service, is scarcely impaired, any more than is the vital capacity of building up organic matter, upon which in turn depends the faculty of giving satisfaction to symbiotic partners—in this instance the birds, by which the plant is dispersed.

Though it be dependent upon the trees in an evil parasitic manner, wherefore its leaves are small and thick, and not very abundant, the mistletoe is dependent in a fruitful symbiotic way upon its feathered partners, as they disperse its seeds. Darwin, in the "Origin," speaks in this connection of the seeds as absolutely requiring transportation by certain birds (foremost among which is the missel-thrush) and of the flowers as having separate sexes absolutely requiring the agency of certain insects to bring pollen from one flower to the other. He further states that the mistletoe only in a far-fetched sense (why not drop that far-fetched sense?) can be said to struggle with these trees; rather, in view of its existence depending on the birds by which it is disseminated, he would "metaphorically" say that it struggles with other fruit-bearing plants, in tempting

the birds to devour and thus disseminate its seeds. Here, indeed, we get the suggestion of a better, more reasonable, interpretation of the phenomenon than that of the bald "struggle for existence." It is a pity Darwin did not adhere consistently to the most important, the bio-economic, sense, here adumbrated, instead of giving us a promiscuous mixture of all sorts of senses, thus with "Natural Selection" obscuring the issue. Darwin here almost goes so far as to say that plants emulate with one another in giving satisfaction to symbiotic partners, which, to continue the interpretation in terms of Symbiosis, is to purchase the right to continued existence by giving other, serviceable creatures a live interest in one's own existence, *i.e.*, by being widely and vitally useful to life, which is more than a real parasite ever does

It is more than doubtful that the mistletoe could continue giving satisfaction to birds if it lapsed into real parasitism, seeing that this spells sterility and emptiness so far as bio-economic service is concerned.

If the mistletoe proceeded too far in the parasitic direction, instead of remaining predominantly symbiotic, it would court obliteration for lack of serviceability. Progress in evil, in other words, is stayed or prevented by an enforced adherence to Symbiosis.

Hence, too, it is as illegitimate for Dr. Skene to cite the mistletoe as illustrating the goodness of parasitism, as it is illegitimate for Prof. Thomson to instance the occasional abuse of the social principle, or the residual good qualities of a frugo-carnivorous animal, in proof of his contention that the solitary carnivorous life is on a par with the social life of the symbiotic cross-feeder.

Let Dr. Skene himself describe for us what I would call the symbiotic adaptation of this plant. This is what he says: "The first question we might ask ourselves viewing the mistletoe on its peculiar perch is—How did it get there? The answer is that it was placed there by birds. The distribution of plants with juicy fruits is usually accomplished by the birds which eat the fruit and carry the seed for some distance before it is dropped, usually no worse but rather better for its

passage through an alimentary canal. The effectiveness of this mode of conveyance is evident from the way in which berry-bearing shrubs spring up far from the nearest fruiting specimen. But this random dispersal is not good enough for the seed of the mistletoe, which must alight on a suitable branch or perish. The pulp of the berry is extremely sticky and, when a bird, typically the missel thrush, eats it, the effect is like that of "stick-jaw" on a small boy. The bird wipes its bill on the branch on which it sits; it gets rid of the viscid pulp and the entangled seed, which stick to the twig. As the juice dries, the seed is firmly glued in position and remains there till, in the late spring, germination takes place. Occasionally seeds may be voided on trees, but the usual mode of dispersal and fixation is that we have sketched. It seems that throughout the whole thousand odd species of the great mistletoe family the fruit possesses this character and the seed thus finds its proper station."

Obviously, there is a precarious element in the life of such a plant, particularly so far as dispersal is concerned: but even a partial lapse into parasitism must be held to produce curtailments and limitations of life as the penalty for the parasitic habit. On the other hand, it is fairly evident from the above description that there is universally but one way of escaping worse curtailment with the attendant degeneracy, and that is by remaining sufficiently serviceable, at least to some important orders of life, which is a lesson well worth learning.

A very different story indeed to that of the partly symbiotic mistletoe is that of the entirely parasitic dodder, for instance, justifying my view that the parasitic principle wherever met with is wholly evil. Let us again take Dr. Skene's own testimony: "When it (the dodder) chances to touch a clover, it makes several close, tight coils round it, and, from the inside of these, suckers are sent down into the host. There is now a source of food substance at its disposal and it begins to grow vigorously and to branch. It makes long, loose coils round the stems and leaf-stalks,

alternating these with a few close tight coils, from which more suckers are produced. This mode of growth is very interesting. The dodder is a member of the bindweed family and its loose coils resemble the coils of a twining plant. The tight coils, however, are like those of a tendril, and like them are made in response to the stimulus of contact with the solid stem which it touches. Here we have a modification of the ordinary mode of twining, an adjustment to the peculiar necessities of the parasitic dodder. Twining and branching, the original seedling ultimately extends into a tangled mass of threads, the " devil's twine " of the apt German common name (*sic*). Unlike the mistletoe, the dodder is a complete parasite. The clover dodder has no green pigment ; some other species have a little, though never enough to enable them to build up the organic matter required for growth. The dodders are thus dependent on their host not only for water and salts, but for their supply of organic food, carbohydrates, and proteins. The suckers of the mistletoe make contact with the water-conducting wood, those of the dodder tap, as well, the living tissues from which organic food may be absorbed. This increased dependence on the host has made possible a notable reduction in structure. The dodder has lost not only its green colour, but also its leaves ; foliage is represented only by a few minute, yellow scales. Instead of the stout, twining stem of the bindweed rooted in the soil, often to great depths, and bearing broad foliage leaves, we have the slender, twining stem of the dodder, rootless and leafless."

Now, having got the real story of parasitism, we can see what emerges—nothing short of this, the inevitable concomitance of bio-economic sterility, criminal wastefulness and criminal destructiveness, with calamitous degeneracy. Seeing that Dr. Skene finds the term " devil's twine " appropriate to meet the case, he should have consistency enough to admit that the loss, the reduction, suffered by the parasite, deserves to be regarded as " satanic simplification," in contradistinction to normal atrophy of a physiological order, one which is

duly compensated for by structural advance in other progressive directions. Evidently, parasitic reduction represents the obliteration of the work of evolution, which may be said in parasitism to be literally undone by "root and branch."

To our Aberdeen plant-physiologist, it does not seem strange that some plants should have seized the opportunity of becoming parasitic; for, as he puts it, a plant growing in a sod thick with the roots of other plants, has every opportunity, in constant contact, of entering into a still closer union (*sic*) with its neighbours. In view of the frailty of life, it does indeed not seem strange that occasional lapses should occur. But is it not strange, after all, that so few plants should aspire after parasitic indolence with its "closer union" and alluring "simplification"? For whose sake or under what control do they remain honest, hard-working, and complex in structure and in composition?

The fact is that parasitism has not "made good" to any extent amongst plants. The vast majority of them have remained honest, and Dr. Skene has to admit this: "The majority of plants are rooted in soil rich in roots, yet the number of root parasites is relatively insignificant."

Speaking philosophically, we may say that there is a preponderance of righteousness in the organic world, preventing such a disastrous course as that of parasitism on the part of the majority of plants. It is the opposite, the symbiotic, principle which has as a matter of fact proved itself victorious in the course of evolution, thus allowing the inference that evolution is constituted in the main by the development of a moral principle.

Let us examine Dr. Skene's attempt to whitewash parasitism, according to the tradition of his school. He says he wishes to put forward the view that parasitism is "not the last resort of the feeble, but a positive step forward, on a new, though it may be downward, path," and that this may be attended by "a reduction which it is usual to regard as degeneracy, but this is not a necessary consequence."

A "positive" step on a "downward path" by an organism which may not (but may yet in some important unrecognised sense) be "feeble," is an argument that must make us suspicious, especially if the development is, as in this case, accompanied by truly devilish propensities. But the Aberdeen specialist carefully refrains from reverting to the dodder at this point of the argument; he takes us back instead to the mysterious mistletoe, with its symbiotic "mistle" and its parasitic "toe," and, in fact, in order, probably, to give more weight to his special pleading, he invokes the "great" mistletoe family as a whole. Probably quite unwittingly, he is trying to defend one principle by invoking the facts belonging to another, opposite principle, an error which is partly due to hidebound definitions—wrong because based on words rather than on principles. Says he: "With perhaps a single exception all the mistletoes are green; they have well-developed foliage, and they build up their own food like other green plants. Only water and salts do they withdraw from their hosts; to be able to do so they have evolved a very highly specialised absorbing system. They do not show reduction and they cannot in any sense be called degenerate."

If these plants are thus scarcely parasitic in principle, why quote them as typifying parasitism, thus conveying a wrong idea of the meaning of that phenomenon? All that we may say is this, that there are rare cases in which an intensification of inceptional parasitism is precluded, or at any rate retarded, by the peculiar circumstances of the case, as instanced by the mistletoe tribe, the peculiarities of which have already been detailed. If the mistletoe is to serve symbiotic birds, it cannot afford to surrender the chief essential of a plant, the power of photosynthesis, which real parasites, like the dodder, serving nobody, actually have surrendered. The mistletoe has not lost a main normality, and is, *pro tanto*, not degenerate and not a parasite. But it has lost a minor normality and certainly is *pro tanto* degenerate, showing the usual stigmatisation of a parasite. According to Dr.

Skene's own description, it is a normal essential of a plant to possess a root, growing into the soil in response to the stimulus of gravity; instead of which, in the mistletoe, there is but a small stump the base of which spreads into an adhesive disk, from which "suckers" grow out. There is here, therefore, reduction proportionate to the degree of parasitism, and this is all that we should expect to find.

In this sense, and, most importantly, in a bio-economic sense, this plant may be called a degenerate. It does nothing for the trees which it despoils, however slightly. That, apart from the apparent exception of the mistletoe, reduction of structure in a parasite is a general fact of Nature, Dr. Skene has, of course, fully to admit. He says this: "In such parasites as the dodder and Rafflesia there is a very far-reaching reduction. The advanced parasite has come to be dependent on its green host for organic food in the way all animals are dependent on green plants; it has departed from the norm of its kind; it has lost much, but it is admirably fitted to the life it leads, and its losses are of things now useless to it."

This is a panegyric of "adaptation," as though this in itself were the *summum bonum* of life, which, a little reflection will show, it cannot possibly be. For the mutual dependence of organisms is founded on principles of service and honest labour, and parasitism is the very travesty of such principles, however well adapted to its nefarious purposes the parasite otherwise may be.

We come now to consider an Aberdeen parasitologist's appreciation of Nature's ways in the matter of parasitism. The contributor is Dr. John Rennie, distinguished by his research into "Isle of Wight disease" amongst hive-bees. He takes "Parasitic Animals" for his subject, and at the outset bids us abandon all thoughts of good and evil; for he wishes to take us through a very fairyland of parasitism, a "Schlaraffenland" as the Germans call it—where such unctuous rectitude as is usually comprised under the term "moral factor" does not count at all. "Clear thinking," according to

this philosopher, requires that we do not import any ordinary connotation of the term parasitism. With the self same assurance as that employed for several decades by academic critics, who say that food had nothing whatever to do with evolution, we are now being told that "it need hardly be said" that the actions of parasites are "devoid of moral significance."

But because this investigator, *qua* specialist, studies parasites in a detached sort of way, as though good and evil did not exist and putting on one side for the purposes of his descriptive work all that natural repugnance to parasites which is felt by ordinary mortals, he has no right to lay down the law for us in the matter of interpretation. This is going beyond his province. Other philosophers will point out that the universe in its fundamental nature cannot be morally indifferent and neutral, seeing that the world can only be known by a knower who possesses a certain moral value, and that an attitude strictly detached from all moral and aesthetic presuppositions, purely receptive as to things good and evil alike, is bound by its very nature to abstract from the value of things, leading to partial views only.

The universe has produced man with his moral values, and for this reason alone, we are entitled to conclude that morality has been a concern of evolution from the first. Better if Dr. Rennie by all means produced his material in a detached sort of way leaving it to others to pass ultimate value-judgment on it.

The incongruities of a lop-sided specialist interpretation abound almost on every page. For instance, Dr. Rennie finds it only most "natural" that our own body, "providing food and protection in a highly favourable degree," should "inevitably become an area of occupation to a wide variety of living creatures."

I demur, since to me this sort of detachment does not appeal at all. This happy-go-lucky sort of philosophy, coming as it does, from a supposed inspirer of medicine, is not at all reassuring. It spells fatalism with regard to the incidence of disease and is apt to encourage a pusillanimous compliance with low conditions. We

cannot therefore allow, in the public health interest, detachment from moral and allied hygienic values to be carried to the point to which this counsellor from Aberdeen has arrived.

Conceivably there may be some error in the plea that we are the ideal soil for parasitic imposition. Conceivably there are some undiscovered but important principles of pathology which might teach us better. Conceivably, for instance, the true ideal is to build up by right living a real natural immunity, averting the dangers here involved. The true norm, according to Nature, may be merely this, that it is "natural" for scavengers to occupy ground that shows morbidity, with a view to the gradual elimination of the moribund—a very different matter from turning us all into the natural prey of parasites.

It is an "unpleasant fact," even according to Dr. Rennie, to be a host to "very unattractive types of parasitic life." Yet he seeks to allay our scruples with regard to the alleged normality of the thing by his superior, detached views. He bids us, in fact, consider our body as but one of a group of "nutritional areas" into which he would divide the globe. *Divide et impera.*

I would advise my readers to have nothing whatever to do with this form of detachment, the idea of which is offensive to our sense of autonomy. When we are so unfortunate as to be ill and helpless, we may be compelled with some amount of resignation to submit to a surrender of our body to physicians as a "surgical area"; but to surrender our body in full vigour as a "nutritional area" to a weakling of a parasite, in obedience to the dictates of a parasitologist, is a far different matter. If we have any sound sense left, we shall repudiate the very idea and shall, in place of such contentment, continue searching for the best means of foiling all and sundry vile creatures seeking to live upon us without any reciprocity whatsoever.

Dr. Rennie is, of course, faced by the fact of the disappearance in a parasite of the structures normal to a creature of active habits, retaining frequently, not

much more than an alimentary canal and enormously increased sex organs.

But, like many of his fellow students, he is so captivated by the wonderful power of "adaptation" exhibited by many parasites, that he would fain have it thought that he is labouring in a worthy kingdom of Nature—a kind of specialist over-enthusiasm, bordering on the fantastic.

These men have no eye to the *tout-ensemble*, and are, therefore, *a priori* debarred from taking broad and practical views. Their self-limitation is almost pitiful, were it not that on occasion their dogmatism can be positively harmful to the public good. The Scotch Kirk has the wholesome institution of a Moderator, and it would be a good thing if science, too, were under some sort of control.

No amount of adaptation shown by a parasite, be it never so finished a virtuoso at adjustments, can make up for the loss suffered in other directions, a loss that is perhaps greatest in directions least looked for by specialists. A parasite, for instance, has lost essential restraint, the maintenance of which is a fundamental necessity of life. Instead of positively constructing, building, serving, the parasite merely negatively and retrogressively "adjusts." That some degree of ingenuity is left even in a nefarious organism is not enough to fill us with admiration for it and to place it above good and evil. There is every evidence to show that parasites in Nature are wastefully using up their patrimony, just as human parasites do in our own society. The young parasite in Nature often shows that the ancestors at one time led a very different life from that now exhibited by the species.

Again and again Dr. Rennie testifies to the repugnance felt towards parasites. But in this we have to see a biological phenomenon, too. It is due to a deep-seated and "natural" abhorrence by the aristocracy of life of a detestable principle which ends by clothing itself in obscene and unlovely forms.

Such repugnance is part and parcel of that natural

antagonism which is bound to divide creatures which follow totally different and contrasting paths.

What is good to us, is evil to the parasite, and *vice versa*.

The learned parasitologist also virtually concedes the fact that a veritable nemesis of parasitic imposition exists amongst those forms of animal life which are notorious for predatory feeding habits, when he says: "The group of animals known as Tapeworms or Cestodes furnish an illustration of parasitic life which carries with it repugnance scarcely equalled by that felt for those external insect parasites which infest the human body. This dislike is doubtless in large measure due to the fact that the adult worms live in the intestine amongst its food contents; and it is also due to their unattractive appearance, coupled with the very great length to which those which are best known may attain. Amongst Vertebrate or Backboned Animals they are widely distributed; and in the lower forms, *e.g.*, marine fishes, they are extremely common."

He opines that Moses, in forbidding the use of the pig and of other "unclean" animals as food, probably knew of the danger of infection, as well he may have done. But we might know even better than Moses to-day, were it not for the all too detached attitude of modern biologists, who declare themselves to be altogether beyond good and evil. We might long have realised, for instance, that we have it largely in our own hands, through judicious feeding, to be associated with beneficial, *i.e.*, symbiotic, organisms, rather than with injurious, infective, *i.e.*, parasitic ones. It now likewise emerges that the symbiotic adjustment and co-ordination of our own organs (upon which freedom from cancer depends) is served better by one class of food than by another. The wrong class of food induces parasitism and malignancy, both amongst micro-organisms and amongst organs. We should not feed so as to be undesirably associated. There are numerous vicious circles connected with our common dietary, a fact entirely slurred over by those who would have us regard our

bodies as " nutritional areas " for parasites. Our own cells themselves will eventually turn into parasites preying upon neighbouring cells if we persist in feeding in a parasitic manner. Nature offers many examples of what one might term biological carnivorism turning into physiological carnivorism. If an insect becomes habituated to carnivorism, it will not be long before the larva, too, contracts carnivorous habits, this implying that the germ-plasm has been permeated by the carnivorous instinct. From this the taint is apt to be communicated to the ordinary cells and tissues of the body. Once the species is thus saturated with carnivorous influences, it is not a far cry to parasitism and malignancy. Pathology has everything to lose from the " detached " attitude which is now fashionable. Moses, by condemning wrong habits, showed himself superior to our most learned modern schoolmen who condone them.

Here are some interesting facts regarding parasitism from Dr. Rennie's own chapter, worth pondering over in the light of my remarks regarding the vicious circle of " in-feeding." In the case of the " broad tapeworm of Cyclops, Pike, and Man," we are told : " Infection in man takes place through the eating of raw or imperfectly cooked fresh-water fish, notably the pike. . . . This tapeworm floats freely throughout its long length in the alimentary canal, and is attached at its original end or ' head ' by a pair of deep, slit-like suckers which grasp the intestinal wall.

" Growth continues in the region immediately behind the ' head.' The essential features of a tapeworm at this stage are : there is no food-canal ; feeding takes place by the simple process of absorption of the already digested food of the host . . . practically the whole length of the worm is given over to the production of fertilised eggs which pass from the host's body to the exterior. Further development can take place only if these liberated eggs reach water in which certain minute freshwater Crustaceans are living."

And thus the infection reaches Cyclops, a water-flea

(Crustacean). "If luck still holds, the water-flea is in turn gulped down by a pike, or failing that, a trout or other fish. Here the larval tapeworm . . . becomes active, and, freeing itself from the body of the water-flea, it bores its way to the flesh of the fish and a further stage of development is reached. . . . Here the parasite remains permanently unless the flesh is eaten by man."

It is fairly evident from this that the devouring of one creature by another is apt to be attended by evil concomitants. It is also evident that what is "luck" to a parasite, is invariably "ill luck" to a more honest creature, and that, hence, there is bound to be a fundamental antagonism, which may be said to be a "natural" antagonism, involving, *ipso facto*, penalisation of the evil-doer. Further, it is evident that our "natural" repugnance to parasites is due, not merely to their unlovely appearance, not merely to the knowledge that they harm us, but to the deep seated realisation of the truly satanic character of their general activities.

If we constitute ourselves scavengers, we must suffer the consequences according to the principle that "little fleas have lesser fleas, etc." We can quite easily avoid the danger of infection, by confining ourselves in our dietary to the spare products of the vegetable kingdom. Our food-plants, as a rule, do not harbour organisms pathogenic to man. Dr. Rennie, indeed, at this stage of the argument, throws out a hint that in the future man's ways of living may become more hygienic, as well they may.

Moreover, we are bidden to wait for further "research," being told that "where complex interrelations between different hosts have been established, the evolution of such life-histories remains for the most part very obscure," which is not too comforting.

Finally, our sympathy is again invoked for the parasite, as though there could be no doubt whatever that it takes rank equally with the rest of the strenuous community of life—"The intricacy and variety of the life-story of parasites at many different levels are but illustrations of Nature's resourcefulness under exceptional

difficulties in meeting those fundamental needs of living which parasites share in common with other creatures."

So long as a specialist can reap distinction by unravelling parasitic intricacies, it seems, he finds the objects of his research worthy creatures, though they may be doing the devil's own work in the world of life. Perhaps there is no harm, in a sense, that this should be the case, so long as we are not deceived by such interpretations.

Let me now summarize the leading facts of parasitism in a way in which orthodox biology, being pledged to a mechanistic, deterministic system, incapable of taking cognisance of good and evil, does not, or will not, epitomise them.

(1) Parasitism is a kind of intensification of the predatory habit.

(2) All parasites show more or less degeneration, according to the intensity of the parasitic habit. Parasitism is the more marked, and its consequences the more obvious, the less effort the parasite requires to make in securing its subsistence and in assimilating the food which it has utilised. The more the "in-feeding" increases, the greater becomes the increase in malignancy.

(3) Parasites are degenerate and weak, and can carry out their depredations only when they encounter weak hosts.

(4) Parasites are in their turn so commonly preyed upon by other parasites that this almost amounts to a leading principle of (the new) pathology. The phenomenon is, indeed, known as hyper-parasitism.

It will also be worth while here to consider the positive contributions to life which a single honest organism is capable of, and contrast it with the negative results, the nefarious activities, of a parasite. Let us take the banana, the value of which as a food is becoming better known every day. In India, the native home of the banana, not only the fruit, but many other parts of the plant are used by medical men. Again, in the coconut tree there is no waste; for every part, from the root to the topmost branch, has a definite value.

The oil is in great demand by makers of margarine, soap, lard, candles, etc. It is used for illumination and embrocation, is a lubricant, and may be taken as a palatable substitute for cod-liver oil; it is also a necessity to the perfumer. Ropes, cables, mats, brushes are made from the fibre. The coconut is used in the preparation of many foods. The copra residue has enough oil left in it to be a good food-cake for cattle. The shell is used in hundreds of ways for making useful and ornamental articles, from combs to linoleum. The felt under our carpets may be made of compressed coir fibre. The husk provides manure, and the bark yields a strong gum. The root has narcotic properties; and so we might go on.

It is, in the first place, due to such and similar wonderful resources of Nature, *i.e.*, the capital of the strenuous community, that parasites are enabled to eke out their wretched existence.

CHAPTER III.

Parasitism the Crucial Test of Biology.

What is wrong with parasites? So ask the thoughtless everywhere, those who have been brought up in the facile belief that a thing only needs to be very general, or an "adaptation" to be normal and, indeed, immaculate.

Some biologists have seen fit to sneer at my views on parasitism, since they are diametrically opposed to their own. My crime has been to have demonstrated, contrary to their teachings, that theft, assault, and murder belong to the abnormal and evil phase of life, and that in the end the robber must plunder himself. My offence has been to have shown that, contrary to all they have taught, co-operation is more fundamental and also more important than competition, and that the interdependence of life is a real fact, the bio-social and ethical corollaries of which must on no account be left out of the reckoning.

This, they say, is drawing far too pleasant a picture of the world. But, surely, in portraying the brighter side of things, I have at any rate not blinked the facts of the reverse side. I admit, nay, I insist, that "broad is the road that leadeth to destruction."

In allocating to pathology a much vaster rangeht an the schools have done, I cannot be said to have erred on the side of discrimination, or to have shirked—as I submit the schools have done—the stern realities of life.

By my steady insistence on the frailty of life, the *vis inertiæ*, and on the difficulties of the truly good life, I certainly cannot be said to have under-estimated the

difficulties that progressive life has to meet at every turn.

I have never omitted to dwell on the great need of discipline and of restraint on the road to efficiency and progress, which should again exonerate me from the charge of camouflaging the "struggle for existence." I have realised, however, that this and similar catch-phrases have been used far too long as cloaks of ignorance, and that an unnecessary, cruel and stupid complexion has thereby been placed on the natural process. Above all, I found it was necessary to obtain more clarity with regard to the vital distinction between two opposite and fundamentally different pathways of life, and it is all to the good that this has led to a due recognition of the duly and permanently successful method of life, on the one hand, and of the inferior and relatively inefficient and even corrupt way of life, on the other.

For some twenty years I have attempted in my publications to show that the orthodox view, which exculpates parasitism, is wrong and untenable. But the devil's advocate is a tough creature, and he still proclaims the old nonsense unabashed. Great is the lure of irresponsibility, and the lax everywhere gladly lend an ear to those who pander to their appetites.

The attempts to whitewash parasitism are as recurrent as those of foisting protection on the British public.

Let us turn to one such recent attempt. It is by Dr. Francis Metcalf Root, in an article on "Parasitism among the Insects," in an American publication, the *Scientific Monthly,* November 24th.

Although Dr. Root deals chiefly with insects, the discussion turns largely upon the position of parasitism generally. We are told that amongst insects parasitism may be considered "either a wide-spread and, indeed, fundamental habit of life or a comparatively rare and recently acquired one, depending on our viewpoint."

Is it not strange, indeed, to learn at the very outset that parasitism might be the one or the other, a common

or a rare thing, according to a particular "viewpoint" which a particular biologist may happen to bring to bear on the matter? Even the man in the street should realise from this that all is not plain sailing with the interpretation of parasitism by the schools. It will be seen in the sequel that inconsistency and equivocation mark the entire discussion and that the "viewpoint," according to which parasitism is a "fundamental habit of life," is the outcome of a purely verbal definition, a definition which takes account of the form-side only and not of the principle involved.

Dr. Root is a biologist to whom evidently the ungenerous and chaotic view of life appeals more than any other. He is as keen as keen could be to belittle Symbiosis and to dismiss it altogether. By so doing he is getting rid of the difficulty he obviously has of having to discriminate between two fundamental economic principles of life, upon which alone a valid definition of parasitism can rest, to wit, that of reciprocity, or co-operation, on the one side, and that of one-sided exploitation of organism by organism—the essence of parasitism—on the other.

No trusting in words, is a boast one frequently hears from biologists, to mark their disdain of the mere "philosopher" who does not carry on "research" (as though they did not owe an immense debt to philosophers); but, on testing the matter, it will be seen that no one more dogmatically adheres to words and definitions, to the exclusion of the spirit of the thing, than the biologist. It would seem that "researching" leaves no time for thinking, so much are these men immured behind words.

> "Who would describe and study aught alive,
> Seeks first the living spirit thence to drive;
> Then are the lifeless fragments in his hand,
> There only fails, alas! the spirit-band.
> This process, chemists name, in learned thesis,
> Mocking themselves, *Naturæ encheiresis.*"

Consider the "generally accepted definition" of parasitism, as vouchsafed for us by Dr. Root: "Para-

sites are living organisms which, for the purpose of procuring food, take up their abode, temporarily or permanently, on or within other living organisms," and again : " Parasite—a living organism which lives on, in, or with, some other living organism from which it derives nourishment." (Webster).

An orthodox biologist has to go to Webster and to work with definitions that are etymological rather than biological ! He has no understanding of his own, and it is no wonder he is subsequently seen to adhere to the mere symbol, whatever be the idea that is (to him) behind it.

When the word parasitism was first coined, nothing was known of Symbiosis, wherefore the former term, having, as it were, been first in the field, obtained a better hold, and also greater prestige amongst biologists than the latter. Whilst this is human, all too human, it is none the less true that originally the term parasitism denoted a taint, a mark of inferiority and of flabby dependence—a lack of self-support and, correspondingly, of " selfhood." This connotation should have been adhered to in biology, too, to say the least.

Universally, a parasite is one who takes sustenance out of the community, whilst failing to put in anything in return. There is nothing in biology to contradict this truth. On the contrary, the more the parasitic habit is looked into, the more it is found to be pernicious all round.

So much is this the case that the question " What is wrong with parasitism " resolves itself into this, " What is wrong with biology ? "

What is wrong with that science we may now proceed to disclose. Biology was allowed to triumph all too easily over the bishops, and, as a result, it has risen to a position so high above the earth (and even above the heavens) as now to be " beyond good and evil." The biologist is the only Adam for whom good and evil do not exist ! Modern biology having, in Shakespeare's words, made of sweet religion " a rhapsody of words,"

has arrogated to itself the prerogative of dogmatic authority.

Look at the medley of incongruities we get in the attempt to summarise the idea of parasitism, when all that is necessary is to say that one-sided exploitation of organism constitutes parasitism :—

A parasite *always* :—

(1) Lives on, in, or with, some other living organism.

(2) Derives its food from the other living organism, which we call its host.

As a rule, also :—

(3) It is smaller and weaker than its host.

(4) Does no serious injury to its host (in the case of True Parasites only).

(5) Often shows ("degenerate") structural adaptations for its parasitic mode of life.

But surely this is misleading, and there is nothing wrong nor necessarily parasitic in an organism living with another, or even in deriving its food from it.

Dependence may, indeed, be said to be the God-given law, and in so far as it has a redemptive basis in service and reciprocity, it is normal and legitimate and the very opposite of parasitism, which is constituted by non-reciprocal dependence.

Paragraph (3) is a kind of corollary of (1) but that it is not a safe criterion to go upon may be seen from the fact that it is hedged in by the proviso "as a rule," and by the serious exceptions which we shall have presently to consider.

In so far, however, as the statement betokens at least inferiority and weakness, we might perhaps let it pass as an inkling of the inherent pathology of parasitism.

The early mammalia were smaller and in some respects weaker than the monstrous and inimical creatures with which they were associated ; yet, in the end, they triumphed in a really progressive manner over their adversaries, and that is more than could ever be said of parasites, whose manner of life is a villainous weakness, one from which a true dominance could never arise.

Paragraph (4) represents a mere figment of the imagination, a mere *ipse dixit*, as I have often shown. The injury is always there, although there are those who would fain explain it away so as to square the interpretation of parasitism with their own prejudices. We shall have to recur to that subject.

When at last we get the admission of serious "structural adaptations for the parasitic mode of life," (5) this is coupled with the innuendo that those who interpret the loss as a genuine degeneration have mistaken the appearance for the reality, as though a creature could not possibly degenerate by "adaptation." One wonders by what other method this could take place. If the parasite does not always show pronounced degeneration, this is due to the fact that the habit may still be too recent for a very marked retrogressive metamorphosis to make its appearance, and that, moreover, biologists are not accustomed to look very carefully for the stigmata of early degeneration—or for that matter, of early disease.

Progressive evolution, as I have often shown, implies bio-chemical and concomitant bio-economic improvements of wide avail towards life generally and attended by modifications of a correspondingly progressive character, all of which entail strength, efficiency, and output of useful labour in a socio-physiological sense. Who would claim such or similar virtues for parasitic modifications?

Could Dr. Root, for instance, enlighten us as to where we are to draw the line between normal and abnormal when dealing with loss of structure? He can do nothing of the kind, but disconcertedly asks us to help him to do this. In trying to improve upon his narrow definitions, which go to pieces on the first attempt to fit the creatures into them, he says: "As far as the insects are concerned, the two essential characteristics may be somewhat amplified. In the first place, a parasite lives on, in or with its host, and may do either *permanently*, like the lice, which even glue their eggs to the hair or feathers of their host—or *temporarily*, like the

bot-fly, whose larva lives in the stomach of a horse, but which pupates in the ground and has a free-living adult stage—or like the flea, which visits its host periodically for blood as an adult and may even spend much of its adult life on the host's body, while its larval stages live happily on in dust and debris whether the host is near at hand or far away. Or finally, a parasite may live on its host only *occasionally*, like the mosquito, which visits the host only for the brief period necessary to obtain a meal of blood."

There is here, indeed, some considerable "amplification" of the definitions. The usual "physical attachment" factor is dropped to some extent to suit some particular cases. Why not more consistently drop it altogether, and have an eye to the principle of the thing instead?

In a trice our friend modifies his previous attitude to suit what he considers to be special cases.

Conscious of some inconsistency, the learned parasitologist continues thus: "At first sight, I admit, it seems far-fetched to consider a mosquito as a parasite. But where are we to draw the line?"

If Dr. Root expects us to help him, he should not take up the attitude that if a parasitologist does not know where to draw the line, he is therefore, entitled to arbitrariness and dogmatism, although these appear to be the only refuges he knows.

"Who would deny the name of parasite to a tick?", we are asked. Our answer is, of course, that no one would deny it if he takes the commonsense view that such predacity as the tick's constitutes the very essence of parasitism, since it amounts to one-sided exploitation. It is the biologists who insist on the factor of physical attachment rather than on the principle of the association, and it is they who would exempt the tick, as also the mosquito, from the taint of parasitism, seeing that these villains are only very temporarily attached to their victims. It amounts, therefore, only to a little dalliance with common sense when we are told that "the most logical and expedient way of deciding the

question seems to be to include even the extreme cases under the general heading of parasites."

Previously, the men of that school demanded " physical attachment " as the chief criterion of parasitism.

The so-called " extreme cases " are so from the point of view of pedantic definitions alone. They are not exceptional cases of parasitism at all from the bio-economic point of view which asserts that " live and let live " is the rule of life and that the alternatives produce disease and degeneration.

Although he is obliged to admit that there are " parasites " which " seem to be " of definite use to their " hosts," yet with Symbiosis, Dr. Root will have nothing to do, since the idea is evidently not congruous with his mentality. That in such cases the associated organisms may be " parasitic " in the same sophistical sense as disease is health seems never to have occurred to him.

He is obliged to admit, too, in the face of his " adaptation " theory, that there are parasites which are definitely harmful, so much so as actively to devour the host tissues and thus to kill the host. Apparently, however, he does not think that there is much difference or much to choose between mutual aid and mutual murder, and so he goes off without further ado to find a loophole for the inclusion of another class of miscreants, which can no longer be excluded, since so great an authority as Wheeler has bestowed the title of " social parasites " on them.

What are those euphemistically-named creatures which sail under the tautological appellation of " social parasites " ? They are those that parasitize a colony instead of an individual, and contrive to obtain their food and that of their larvæ from the supplies brought in by the working members of the colony.

In the case of the " social parasites " practically all the aforesaid orthodox definitions of parasites are abrogated. But what matters a little inconsistency to those who promulgate the idea that mere expediency has been the leading principle of life ?

So we get the admission that, with regard to the in-

juriousness of parasites, one may have two views although Dr. Root prefers the one which declares that parasites are not as a rule injurious.

This is what we are told: "The biologist, taking a general view of the immense series of parasitic organisms, and noting that only in rare and exceptional cases does obvious injury to the host result from the activities of the true parasites, naturally considers that cases where the parasite does injure the host represent instances of incomplete adaptation. He would point out, for example, that even among the trypanosomes, to pick out a group whose very name brings to our minds a vision of deadly disease, we know many more species which are innocuous to their chosen hosts than we do injurious species.

"And it is even thought that the species most deadly to human beings are accidental introductions into man and are themselves harmless to their original hosts. On the other hand, the physician, usually knowing nothing of parasites except the symptoms which some of them produce in human beings, is, of course, prone to believe that the injury of the host is an essential property of a parasite, and to declare that even when we can see no injury one must nevertheless be present."

I would back the physician's view against these conjectures. It is evident that Dr. Root has rendered his case far too easy by his repudiation of Symbiosis (as the very opposite of parasitism) and by his definition of the non-injuriousness of parasites. If a parasite is named that is notoriously injurious, our friend says that it is not a parasite proper and that there are many that we have not seen which may be far from injurious. We should like to know how far removed from injuriousness these latter are, and whether perhaps they are far enough removed to be not parasites at all but symbionts.

Biologists may be impressed by the wide prevalence of parasites; but this is not enough to render the habit an immaculate or normal method of life. We have no right to argue from the abuse as to the use, however

common the abuse. Two wrongs do not make one right.

We must not blink the fact that injuries are only too likely to be present, although not conspicuous at first. There are none so blind as those who will not see. The majority of biologists at the present day evidently want to put "adaptation" in the place of disease. The public have an interest that such blinking of vital facts should no longer be tolerated and they should assist those who wish to dig a little deeper than the mere surface of things, for much depends upon a reformation of biology, as I have often shown.

The interests of a parasite are, in the very nature of things, so diametrically opposed to those of an honest organism that for this reason alone the association is certain to be shorn of fruitful effects. If the host gain in strength, he may devour or otherwise eliminate or sterilise the parasite. All loss of strength on the part of the host, on the other hand, means gain to the (otherwise weak) parasite. The parasite is not likely to help the host to health and strength to his own undoing. And it increasingly adapts itself to its satanic task. Only in that sense can one speak of a "completely adapted" parasite. One "incompletely adapted" is one who has not yet sufficiently got the better of the host, powerless to meet the imposition, because of some general and increasing powerlessness upon which the parasite battens. What is behind the special pleading of biologists in the matter of parasitism is evidently this —that they want to hide their ignorance with regard to disease behind the shield of "adaptation."

Once disease is properly tackled, however, especially by the study of the early departures from normal health, this will surely cut the ground from under their feet so far as at least one half of their pet theories are concerned.

It is interesting to note the way in which Dr. Root gets over his qualms as regards his definitions of parasitism. Logically, these would oblige him, as he frankly acknowledges, to class all "vegetarian" (cross-feeding)

insects as parasites—a proposition, which even he feels, is absurd. He has even an inkling that we might have to make some distinction between those animals which are moderate and those which are immoderate in their demands on the plant. He adumbrates, in fact, what I have called "plant-assassination."

This is what we are told: "You will no doubt have noted that all the definitions specify that a parasite lives on or in "another living organism" and derives its food from it. We cannot deny that plants are living organisms, and so at one stroke the great majority of vegetarian insects become parasites. There are, it is true, certain insects which feed on small plants and devour them whole, and may thus be considered as predators on the vegetable kingdom. But the great mass of plant-feeders, including those who get the leaves, those who suck the sap, the borers, the miners, and the gall-makers, must be considered parasitic in their mode of life among insects, grading into the saprophytic habit on the one hand and into the predaceous on the other."

We shall certainly hesitate to accept the "sense" in which parasitism may be considered the fundamental habit among insects, and we shall prefer to think that there is something wrong with the definitions. We must in fairness give even an incriminated species the benefit of a doubt, lest it be found that it in reality renders some hidden counter-service to the plant.

Nor shall we fall into the error of considering saprophytes and predators as the usual offshoots of parasites for the converse is usually the case, as we shall presently see, and as I have often demonstrated.

In speaking of the blood-sucking insects, the learned parasitologist offers us the following gem of special pleading: "In all these groups the habit of feeding on vertebrate blood seems to be a response to a large supply of unusually nutritious food to enable the female to develop large numbers of eggs. But no intermediate forms now remain to tell us just how these

females came to discover that blood offered such an accessible and nourishing food supply."

But where is it ordained that the female should develop a large number of eggs? Orthodox biologists take it for granted, quite arbitrarily, quite unphilosophically, and quite unscientifically, that it is somehow ordained that she should. They say, as did Prof. G. P. B., my critic in *Nature*, that we have here to deal with an ancient habit, and leave it there. But this is not good enough for one who is not content with "ancient habits" any more than with slothful habits, be they of life or of thought, but who is inclined on all matters to think for himself. Should we not pause sometimes and reflect that Mrs. Mosquito, in laying so large a number of eggs, is contravening some fundamental law of organic solidarity, to the effect that no species shall propagate beyond need and usefulness in the world of life?

Scoffers will say that this is a Utopian idea; but the case of the cancer cell gives furiously to think. Here, too, we are dealing with excessive reproduction, abnormal in respect of solidarity—although here physiological rather than biological. But we must not draw too fine a distinction between the physiological and the biological spheres—mere conventions—and we must admit the need of the same principles of mutual accommodation of units in either case. There is now a consensus of medical opinion that the cancer cell by its behaviour constitutes itself a parasite. We may thus lay down the general rule that there is an inverse proportion between widely availing usefulness and propagation. There are many other indications to support this generalisation, to which we shall recur.

Every species, no doubt, may be supposed to be eager, if left to itself, to replenish and to inherit the earth. But the numbers are kept down by the contending wants and rights of others. We are only beginning to learn how close is the interdependence of life, both physiologically and biologically. The vegetable cell, for instance, lives, feeds, respires, grows and does many different kinds of work. But it does not live unto

itself alone. In all its manifold activities the cell influences and is influenced by other of the well-nigh innumerable cell units of the plant commonwealth. Indeed, as Prof. Sir Frederick Keeble says, the messages which by word of mouth, by post and telephone, telegraph and wireless, pass between members of our own commonwealth and leave us but little peace, are few in comparison with those sent and received by the living cells of plants. Throughout life they are always "listening in." But we must not stop at that; for the plant commonwealth is inextricably interwoven with the animal commonwealth, and forms, indeed, a larger commonwealth with it. Here again is inter-communication, although we have no doubt as yet learnt only a modicum about it, and here, too, there is mutual control beyond what we at present imagine.

Only abnormally, by dint of trickery, involving pathology, can a species flout the control of the animate environment. Two ways are open to a species in the use of its patrimony, (*a*) that denoted by "erwirb es um es zu besitzen" (earn it in order to possess it) and, (*b*) the wasteful way which consists in spending merely, with never an "earned increment" added to it. The latter way is that of retrogression, for, as is well known, if you do not go forward, you go back. It can scarcely be pleaded that there is compensation for a parasitic species for its weakness and its smallness in size in the fact of enormous reproduction; nay this fact denotes physiological weakness; and the majority of eggs perish—a great waste of physiological expenditure—without so much as a chance of reaching maturity. It is quite as much against the eternal economic law of Nature, as it is against common sense that a parasitic, *i.e.*, non-productive and non-reciprocal creature should be entitled to a "large supply of unusually nutritious food." Such a supply, moreover, would spoil even a strong non-parasitic species; and we may conclude that in its ways of reproduction the life of a parasitic species is as illegitimate and morbid as in those of nutrition. The alleged "response" of Mrs. Mosquito is in reality

the momentum acquired along the inclined plane of life. It would be more candid on the part of biologists, instead of speculating about such "responses," to admit that they have not yet given sufficient attention to the vitally important matter of food as it affects reproduction.

If Dr. Root had an appreciation for what I have termed an abnormal metabolism, he would not need to ask us how these females came to discover that blood offers such a nourishing food supply, thus exposing the weakness of his position.

The inclined plane of metabolism follows in the wake of bio-moral degradation, beginning with plant-assassination, *i.e.*, food stolen from the injured plant by short cuts, without reciprocity, without the slightest compensation. In the course of such "adaptation," all former (normal) restraint goes by the board—idleness being the end of chastity. So broad is the road to retrogression that it means all manner of openings for depravity, for morbid indulgences. Correspondingly, there is a variety of forms of nemesis for parasitism.

"Selbst die Hœlle hat ihre Rechte" (even hell has its laws), according to Goethe, and some degree of rectitude is required even from a parasite, as in the matter of parental sacrifice. Here, however, owing to the general lack of integrity, the physiological and biological bankruptcy of the species makes itself calamitously felt. There is little of honest endowment, and less of biological goodwill, left to be handed on to offspring, and very rarely, indeed, can a parasitic insect survive the period of reproduction at all. Multiplication may be great in numbers, but reproduction is practically synonymous with death—the result of general impoverishment. Often we get the spectacle of embryonic cannibalism, all of which goes to show that parasitism is the foe of evolution. The history of parasitism, indeed, furnishes negative evidence of a similar view to mine, expressed recently by Dr. William Patten, an American evolutionist, (*Scientific Monthly*, December 1924), to the effect that the methods of evolution exemplify the

successful usage of the highest ethical and moral principles. "They show us the ideal methods of democracy and Christianity in successful operation on a universal scale." So that writer holds with me, that there is evidence in Nature of the preserving of the more righteous ways of doing things, which ways, "because they are more righteous, are more fruitful or creative."

This is how Dr. Root himself confirms the truth of my contention that parasitism is frequently evolved from predacity (in the orthodox sense): "In the blood-sucking midges (Ceratopogoninæ) it seems likely that this habit of life evolved through a predaceous stage. While the majority of midges feed on nectar and other plant juices, some of the Ceratopogoninæ have developed the habit of frequenting flowers, not to feed on their juices, but to prey on the smaller flies which are attracted to them. Other species of the same group have taken the short step between sucking all the juices of smaller insects and sucking a portion of the blood of larger insects. And finally we have a hint as to how the transition to a diet of vertebrate blood *might* have occurred in the case of a single species of the blood-sucking genus Culicoides. This species, *Culicoides anophelis*, does feed on blood, like most of its relatives, but it obtains its blood-meal by driving its proboscis into the swollen abdomen of an engorged mosquito."

The transition clearly is from the status of an erstwhile self-supporting and moderate cross-feeder, *via* the phase of plant-murderer to the rank of a parasitic "in-feeder." The inevitable concomitant of such a transition is the evolution of an abnormal metabolism, *i.e.*, the metabolism becomes less and less consonant with, and finally subversive of, the scheme of co-evolution between plant and animal, with its evolved requirements of reciprocity in the exchange of substances and of other services, which reciprocity is so all-essential to the maintenance of organic life that all health and progress depend on it.

We may take it that in the evolution of an "in-feeder" the usual efforts of the "fundamental capitalist," the

plant, to constrain the food-seeking insect to reciprocity have been foiled by the trickery and self-deception of the insect.

That the plant-assassin, once it has habituated itself to the flouting of essential control, will not stop short at smaller injuries inflicted upon the plant, but will become more exacting as time goes on, and destroy plants wholesale, is almost to be expected. Nor is it to be wondered at that in the course of such profligacy some creatures turn in-feeders, by injuring, parasitizing, and otherwise murdering their nearest kin and subsequently even higher creatures than themselves. This is the exact analogue of the usual order of events in ordinary moral pathology where sanction after sanction is seen to be going. The road to evil is proverbially easy. We can scarcely be surprised to find that frailty is the common lot of life; otherwise we should have to ascribe the prerogative exclusively to *homo sapiens*, which is not satisfactory.

What Dr. Root has to say concerning the evolution of the blood-sucking habit tallies with my views with regard to the evolution of the in-feeder. In a small group of Muscoid flies, the blood-feeding habit is common to both sexes. "Here we find an exceptionally interesting series of forms, showing not only the acquisition of the blood-sucking habit but also the gradual modification of the fleshy spongy proboscis of the house-fly into the slender, piercing stiletto of the tsetse. In this group we also find, rather surprisingly, that the blood-feeding habit has become well developed in certain species before any mechanism for piercing the skin and obtaining the blood is available. The common house-fly, *Musca domestica*, is almost omnivorous. It feeds on any nourishing material which is in liquid form or can be liquefied by the regurgitation of fluid from the fly's crop. While we usually think of a fly as feeding on human foods, on garbage, and on liquid filth, it will also take blood or serum when they exude from the body or are otherwise exposed, as any one who has tried to dry blood-smears in a fly-ridden room can testify. Certain

other species of Musca have adopted this latter diet exclusively. Lacking a piercing proboscis themselves, they frequent cattle or horses, awaiting the arrival of a blood-sucking Tabanid or Muscoid fly. As soon as such a fly has pierced the skin it is surrounded by a ring of these Muscas, which crowd and hustle it, sometimes forcing it to withdraw its proboscis and seek a meal elsewhere. When the blood-sucking fly has finished its meal or has been persuaded to depart, the muscas eagerly surround the site of the puncture, lapping up the surplus blood which trickles from the wound."

One morale clearly is that an evil function in course of time produces an evil mechanism, whilst it at the same time engenders many evil correlations, which must be allowed for, if the real significance and value of the underlying habits are to be rightly assessed.

"*Das ist der Fluch der bœsen That dass sie fortzeugend Uebel muss gebæren,*" (such is the curse of one evil act that it must generate other evils).

One correlation of the evolution of the in-feeder, of course, is the increasing clash with the interests of the more honest organisms, which latter are thus roused to greater efforts towards the overcoming of the evil, in the doing of which they are apt to gain increasing dominance *vis-a-vis* to vermin.

We may glean further evidence respecting the aforesaid transition from cross-feeding to parasitic in-feeding from the following: "In such permanent ecto-parasites as the lice, the parasitic habit seems to have arisen from a saprophytic mode of life. The best authorities now believe that the bird-lice and the blood-sucking lice are closely related, perhaps representing branches which have arisen from the same common stock and have become specialised in somewhat different directions. Forms which may be close to the original stock from which the lice arose are still in existence under the name of book-lice.

The best known of these little creatures is the species which is so often found in old books, or eating up museum specimens or even attacking starched clothing.

Others are to be found in the nests of birds and mammals, eating all sorts of debris, including, of course, the cast-off feathers or hair. It is easy to imagine such a species forsaking the nest for the body of the host itself, still feeding on feathers, hair, or bits of dead skin. A few minor structural adaptations would then give us a bird-louse. At some time, early in the development of bird-lice, some of them must have discovered the great reservoir of nourishing blood just beneath the skin and developed piercing mouthparts for the purpose of tapping it. We can even make a crude approximation of the date of this historic moment in the annals of the lice, for, so far as we know, those primitive mammals, the marsupials, are infested only by bird-lice, while every other large group of mammals has developed its own characteristic groups of blood-sucking lice. It is possible, then, that these latter originated after the marsupial stage of evolution had been left behind, but before the primitive stock of the higher mammals had undergone any further extensive subdivision."

The facts of the case, then, plus a little imagination, go far towards confirming my view of the evolution of the in-feeder. Such evolution constitutes " progressive " retrogression—backsliding from the most important—*viz.*, the bio-economic and bio-social point of view.

CHAPTER IV.

*The Plant as Universal Provider.

"The wonderful power which plants exercise in building up their tissues from carbonic acid, water, and nitrogen, contrasted with the powerlessness of animals to utilise these building materials until they have been assembled by plants, is a phenomenon too fundamental and illuminating to be withheld, as it now is, from all but the few." *Dr M. O. Forster, British Association, 1921.*

"Every plant in the world lives for others; it sets aside something costly, cared for, the highest expression of its nature. The seed is the tithe of love, the tithe which Nature renders to man . . . Milk, the date, the raisin, the banana, and the bread-fruit, the locust and the honey, the eggs, the grains, the cereals and the legumes constitute the great bulk of the foods of the world." *Henry Drummond.*

"There is no life-reaction in even the highest animal which has not been fore-shadowed in the life of the plant."

Sir Jagadis Chander Bose.

Huxley declared long ago that the one thing needful for economic production is the green plant, as the sole producer of vital capital from natural inorganic bodies. "Men might exist without labour (in the ordinary sense) and without land; without plants they must inevitably perish."

Our dependence upon plants is, indeed, most wonderful, and, with more light thrown on the matter since Huxley's days, a new thrill of interest can now fortunately be given to this important subject.

The plant is essential to the animal, much as the female is to the male, as the mother is to the child. If the vegetable world was not pre-ordained for the express purpose of sustaining and benefiting the animal, it has certainly become what it is by some supreme cosmic and economic necessities, and we should do well occasionally to ponder what is here involved.

* The substance of this chapter is reprinted from the "Medical Times," Oct. and Nov. 1924

The harmonious co-adaptation, as it is sometimes called, between the " kingdoms " is a result of division of labour, combined with symbiosis, which rendered the evolution and the well-being of the one " kingdom " dependent upon that of the other. By symbiosis I mean, not parasitism, commensalism, but definite, almost deliberate, mutual adaptation for the purpose of mutual service on the part of living things, nearly always of different orders of creation, broadly, that is, between the plant and the animal (" Norm-Symbiosis ").

Look what we owe to the plant in physical energy alone.

Messrs. W. Butler and J. H. Coste have shown in their contribution to the subject of ' Seasonal variations in the dissolved oxygen content of the water of the Thames estuary " (*Bio-Chemical Journal*, Vol. XVII., No. 1, 1923) that the amount of oxygen in seawater is often found to be more than such water would naturally take into solution. This excess varies with light and temperature, and is, according to them, doubtless due to the production of oxygen by marine vegetation. Particularly in the spring the seas are " a great natural factory where free oxygen is produced on a scale, which, having regard to the relative areas of sea and land, may conceivably exceed that of land vegetation." This oxygen adds to the purifying value of the tides as they sweep up the polluted estuaries. The waves as they break on the shore liberate the gas in its most active state and add to the health-giving value of the sea-breeze. It has long been realised that the sea, through the carbonates which it contains, prevents an excess of carbonic acid in the air ; it now appears that by continual contributions it keeps up a steady proportion of atmospheric oxygen.

The marine vegetation, then, not only provides the wherewithal of animal life in the sea, but has essential surpluses, such as free and active oxygen, to spare, to render animal life tolerable and successful upon the land —a fact of no small significance.

One might recall, also, in this connection, a theory

put forward at the meeting of the British Association at Hull, 1922, by Dr. F. C. Eve, who, in speaking of life and energy, described the law of " katergy." He submitted that the function of plants was to afford sunshine an earlier and better opportunity for the degradation of its energy than would be possible without plants, and that at the dawn of life plants were dragged into existence by this tendency of energy to flow downhill to a lower level. This was the law of katergy, a new word, meaning the flow of energy in the ordinary downhill direction, which has given us the stars, the dead earth, and the sunshine. The strainings of this law, Dr. Eve thought, provide the driving force, not only of astronomy, chemistry, and physics, but also of living things. Plants might thus be regarded as the materialisations, highly evolved and perfected, of the straining of solar energy to katergise. Dr. Eve is of the opinion that he has in this way supplemented Darwin's " survival of the fittest." Fit for what ? For the optimal katergy in their environment. It was the best katergisers, according to him, that survived.

Although plants have no nervous system in the strict sense, yet they are " irritable," *i.e.*, sensitive to various outside influences. They have their senses. There are, it is true, no special sense-organs in plants ; but, as Prof. A. Thomson says, " There are none in an animal like an earthworm, which is none the less sensitive to vibrations, light and shade, chemicals and odours." According to Prof. Thomson, there may be sensitiveness without sense-organ ; there may be sensitiveness without nerve-cells ; there may be movement without muscle-cells. With the stalk of the leaf as the main " effector " and the blade as the main " receptor," he thinks, the plant has got farther in sensitiveness than sponges.

Indeed, as Prof. Thomson puts it, " the animal lurks in the plant." He speaks of a sixth vegetable sense, the sense of touch which many plants have in a high degree. " The tendrils will respond to the light touch of a thread, the stamens of the rock-rose to an insect's

legs, the mouth-like stigma of the musk to a pollen-grain, the leaves o. the sensitive plant to a sudden jar. It is very interesting to find that there are, as in many animals, special ' receptives ' which convey the stimulus of touch inwards. On the tendrils of the cucumber there are cells with minute insinkings which agitate crystals of calcium oxalate and these excite the living matter. On the moveable stamens of the barberry there are touch-papillæ ; on the leaf of Venus's Fly-Trap and on the sensitive plant there are touch-hairs. All this is very animal-like ; there is receiving the message and passing it on, and there is answering back."

One wonders when the fact that plants and animals are co-evolved as symbiotic partners will be duly grasped by biologists. Probably not until " Natural Selection " is finally discarded. I have endeavoured to show elsewhere that the success of the insects, for instance, is largely due to their wonderful achievements in symbiosis with plants. There is there no need to invoke Natural Selection at all. Success is clearly traceable to positive factors : the summation of powers through co-operation. Insects show a wonderful wealth of species ; and they have in many ways, as is well-known, produced a wonderful development of the social life, all of which is the concomitant of the wonderful symbiotic " adaptation " they entertain with plants. Insects do not stand alone in the matter of pollinating plants. Birds and mammals, too, render themselves useful to plants in that respect.

In speaking of the humming birds, many of which pollinate flowers and destroy unwelcome floral visitors, thereby making themselves highly useful to their food plants, Prof. Thomson thinks we may say that they are perhaps relieved from very stringent natural selection, because of their small size, because they find their food so easily, and because they have few enemies.

When shall we cease speculating after that futile manner ? Would it not be simpler and also more rational to see in the fact of the symbiotic life the secret of success, as in the unsymbiotic life there is to be seen

the source of failure? You cannot do wrong without suffering wrong. Those who do well, suffer less from competition, and in the end get on better, than the wrong-doers. Here we have action and reaction. Here we have Nature in her consistency. Here we have to do with factors that we can understand. The "operation of natural selection," elegant phrase though it be, is mere "high falutin language," a piece of scientific obscurantism. In orthodox biology, one never knows when "Natural Selection," the arbitrary, the incalculable, allows a little extra latitude for escape to some "favoured" species. That Nature works by "favour" seems to appeal very much to some folks, used as they are to log-rolling and to patronage. One never knows, on "Natural Selection" lines, whether a species has succeeded because it has been "selected," or because it has succeeded in the opposite, namely, in escaping from "selection." One never knows when physiological simplification is not parasitic degeneration, nor when health is not disease. There is there room, at any rate, for all manner of ingenuity. So there was in the old times when scholars disputed how many angels could dance upon the point of a needle. If the success of animals consists in a life of legitimacy, of mutuality and of serviceability to plants, why not plainly say so? Why, instead, delude yourselves and delude the world with a highly composite but ill-compounded quantity?

Let us see how in the tundra the mammals escape from the rigours of "Natural Selection." How do they manage there to be vigorous, resistant, viable, and endowed with the gifts of the senses?

Again we may let Prof. Thomson be our guide. He has to tell us something regarding the secret of the reindeer. "The long, dense hair and the thick skin must help to protect it against the Polar weather. The shovel-like feet, with the hoofs spreading out under pressure, are well-suited for running on snow-covered or boggy ground, and they also serve for scraping down to the lichens. From the wolf it is more or less saved by its keen senses of sight, smell, and hearing, and also by

its enduring speed. From ' the wolf at the door,' it is saved by its capacity for thriving on scraps of vegetation of all sorts—from the lichens on the mountains to the seaweed on the shore."

In other words, the animal is a cross-feeder, and because of that it is favourably placed at once in many directions. The same is true of another cross feeder, the musk ox, regarding which the same erudite zoologist tells us : " This unique ruminant, which links cattle and sheep, is represented by fossil remains in North Europe and Asia, but is restricted nowadays to the barren grounds of Canada. It is a strongly built animal, about three feet high at the shoulder, with shaggy fine hair, on the whole deep-amber coloured, and sometimes harmonising protectively against a background of rock. Apart from man it has no enemy but the wolf, which it baulks by its gregariousness—herd against pack ! "

So in *Chamber's Journal*, May 1923, we read concerning the musk ox of Northern Greenland : " It seems marvelous that an animal with such pronounced vegetarian taste should be able to obtain a living in these barren and inhospitable wastes, where, in spite of many difficulties and spells of hard times, it manages to get along fairly well. Arctic grass constitutes its most important food, and this it supplements with scraps of moss, heather, and Arctic willow. Access to these luxuries is facilitated, moreover, by the frequent violent gales which blow away the snow from comparatively large areas."

Needless to say, what is usually omitted from such accounts, these mammals are in symbiotic alliance with their principal food plants ; and they are thus in large part themselves responsible for the fashioning of a suitable environment.

The success of cross-feeding pioneers makes it possible for some few scavengers to eke out a miserable existence. The Arctic fox is an example. It " lives by its wits," as Prof. Thomson says. Often it must " find it difficult to keep body and soul together." If it cannot get other food, it will feed on a whale's carcass, stranded on the shore—as well it might. It is, however, very " resource-

ful," so Prof. Thomson thinks. Evidently it lives up somewhat to the reputation of the renard type—*chevalier d'industrie*, as the French call it.

There is a widespread prejudice that in the sea organisms can only exist by devouring others. Predacity is there thought to be the only rule, as though in the sea animal life could exist without the plant, as though there were not symbiosis also in the sea, where it is just as indispensable as on the land. The presence of vitamins in cod liver oil has stimulated the inquiry into the origin of the vitamins in the sea ; and we have since learnt that we must revise our ideas regarding the food of fish in many ways. Instead of regarding the cod as a ravenous consumer of the smaller fry of the ocean, we must place him in the status of a plain sea-grazer, *i.e.*, the cod obtains his vitamins chiefly direct from the plant, their true source. As with the cod, so it is with other fishes, as I have often shown.

The probability is that we shall have to revise most of our ideas concerning fitness and ultimate survival

In his book, "The World of Life," the late Dr. Russell Wallace has collated some evidence of vegetable usefulness to man.

Taking first the innumerable different kinds of wood, whose qualities of strength, lightness, ease of cutting, and planing, smoothness of surface, beauty and durability are so exactly suited to the needs of civilised man, that it is almost doubtful if he could have reached civilisation without them, he shows that the considerable range in their hardness, in their durability when exposed to the action of water or of the soil, in their weight and in their elasticity, render them serviceable to him in a thousand ways which are totally removed from any use made of them by the lower animals.

Few of these qualities seem essential to themselves as vegetable growths. They might have been much smaller, which would have greatly reduced their uses ; or so much harder as to be almost unworkable ; or so liable to fracture as to be dangerous ; or subject to rapid decay by the action of air, or of water, or of sun-

shine, so as to be suitable for temporary purposes only. With any of these defects, they might have served the purposes of the animal world quite as well as they do now; and their actual properties, all varying about a mean value, which serves the infinitely varied purposes to which we daily and hourly apply them, may certainly be adduced as an indication that they were endowed with such properties in view of the coming race which would alone utilise them, and to whose needs they minister in such an infinite variety of ways.

As one example of what such a different quality of timber as above indicated might mean, let us remember that from before the dawn of history down to the middle of the last century every ship in the world was built of wood. Had no wood existed, suitable for sea-going vessels, the whole course of history, and perhaps of civilisation, would have been different. Without ships the Mediterranean would have been almost as impassable as was the Atlantic. America would still be unknown, as well as Australia and possibly South Africa, and the whole world would be for us smaller than in the days before Columbus. And all this might have happened had the nature of vegetable growth, while differing little in external form and equally well adapted for unintelligent animal life, not possessed those special qualities which fitted it for ministering to the varied needs of intellectual, inventive, and ever-advancing man. Leaving out of consideration the vast number of fruits and cereals, and vegetables, which supply him with varieties of food, which may be of more importance to man in the future than they are now, there are the innumerable drugs which enable him to avoid some of the evils brought upon himself by his ignorance, his dissipations, or his wilful neglect. To these we may add the various "balsams" so much used in ancient surgery—balm of Gilead, friar's balsam, balsam of Peru, benzoin, camphor, etc. Then there are the ordinary resins and gums, so useful in the arts—copal, dammar, mastic, kauri, gum-arabic, tragacanth, asafoetida, gamboge, etc. Among the numerous dyes are

arnotto, Brazil-wood, logwood, can wood, fustic, indigo, madder, turmeri and woad. Vegetable oils, used for cooking, lighting, perfumes, medicines, etc., are very numerous. Such are candle-nut, castor oil, coco-nut oil, colza oil, olive oil, cotton-seed, linseed, and rape-seed oils, cajeput oil,and innumerable others in every part of the world, known or yet to be discovered. Perfumes and spices are also extremely abundant, such as caraways, cinnamon, cloves, mace, nutmegs, patchouli, peppermint, orris-root,sandalwood, sasasfras, tonquin-beans, vanilla, and the many essential oils from highly perfumed fruits and flowers. Of foods and drinks, not used by the lower animals, are arrowroot, tapioca, sago, sugar, wine, beer, tea, coffee, and cocoa. There remain a number of vegetable products invaluable for arts and manufactures—cotton and flax for clothing, hemp for cordage, rattan and bamboo for tropical furniture, boxwood for wood-engraving, gutta-percha for machine belts and a great variety of economic uses, and, lastly, indiarubber, one of the greatest essentials of our chemical and mechanical arts, without which neither the electric telegraph, the bicycle, nor the motor-car could have reached their present stage of perfection, while no doubt many equally important uses remain to be discovered. Dr. Wallace shows to some extent that whilst so many of these varied products are of use to the plants themselves, they have also a wider usefulness. Their utility to man, he says, is not merely an accidental result, but has a profound significance. He almost adumbrates the fact that the wider usefulness is a concomitant of co-evolution, *i.e.*, of progressive symbiosis between the "kingdoms."

Botanists have marvelled at the fact that the plant has succeeded as well as it has done, seeing that it is vulnerable, weak, and fixed to the soil, incapable of running away from enemies. So they are astonished at the number and diversity of its contrivances for protection. But have they ever realised the magnitude of the pact between animal and plant and the transcendent significance of the symbiosis here entailed ?

CHAPTER V.

* Plant Assassins and their Nemesis.

Pathology has been very aptly described as the seamy side of biology. All that is perverse, both in action and in constitution, is here gathered together: a motley crowd, a Mephistophelian swarm, notorious by the insignia of depravity and disease.

The stigmatisation of extreme perversity is conspicuous enough: the habitual murderers, the parasites, the liers-in-wait bear the brand of Cain on portions of their surface, in their dull, muddy, blotchy colours and uncouth or hideous shapes—their "bizarre" appearance.

But we must on no account assume that it is only rank predacity that is thus "penalised," and we must not overlook the early stages of penalisation, if we wish to obtain a comprehensive understanding of pathology development and its origins. The inexorable logic of the universe is such that every kind of shady or indecent behaviour, every incontinence, or other form of biological misconduct, inevitably dooms the organism to suffer the penalties of disease.

The wide prevalence of biological evil has deceived us into believing that its presence is inevitable and even normal. And our own malpractices and frequent compliance with low conditions have lulled us into a false sense of values, and even into a loss of repugnance to biological evil.

We have not yet learnt to look the facts of disease honestly in the face, in biological science.

* The substance of this chapter is reprinted from "The World's Work," July 1921.

Let us take a concrete, though a comparatively mild, case of biological misconduct, exemplifying the contention that illegitimate ways of life result in pathological developments, and that throughout biology there is this causal connection between anti-social conduct and decay, just as we sometimes cannot help noticing it in human society.

If the honey-bee, instead of obtaining its nectar normally, obtains it, as Darwin says, "feloniously," *i.e.*, by biting a hole into the corolla, it makes itself guilty of illegitimate conduct; and it is well known that as a result of such conduct, the bee may become debauched.

Nor is the damage confined to the bee; the plant thus abused may revert to an inferior condition of existence, to self-fertilisation in fact, and prolonged self-fertilisation, as Darwin has shown by classical examples, is "abhorred by Nature."

Moreover, the whole of organic life must needs be the poorer if such bad behaviour is practised on the large scale; and, manifestly, if the ill-conduct were allowed to pass with impunity, organic life would soon be reduced to chaos.

Mr. H. J. Lowe reports as follows in *Nature*, August 12th, 1920:

"The humble bees follow the habit they have long acquired in rifling the tubular flower of the jasmine of its honey: that of gnawing a hole near the base of the corolla, through which the proboscis can reach and extract the nectar.

"A similar plan is now adopted with the flower of the scarlet-runner bean. The bee no longer dives into the more open side of the bloom, where it would brush against the protruding anthers and stigma, in an endeavour to reach the nectaries at their base, but on alighting moves immediately to underneath the blossom, and, if not already done, gnaws through the calyx and sheath of filaments close to the nectaries, which are then easily reached and emptied. The honey-bees follow, and this season I have observed no instance of an insect attempting to reach the honey in the way the develop-

ment of the flower suggests as that of reciprocal advantage.

"Though perfectly adapted to self-fertilisation, the flower, by the change of habit of the bees, would appear to lose the occasional advantage of cross-pollination, and the injury done by the gnawing of the bloom apparently causes a diminution in the amount of pollen formed and quicker fading and falling of the bloom, with the probable consequence of fewer pods 'setting.'"

If there are fewer pods "setting," it follows that man, who fosters both bean and bee, as a third party, is injured by the felony of the bee. But to offend against the vital interests of man, the arbiter of organic life, is no trifling matter, as many animal and vegetable species, in the course of evolution, have found to their cost.

Liability to bee-disease is probably fundamentally due to such and similar misdemeanours on the part of the insect.

Invariably the activities of a robber react injuriously upon him. The predaceous life is not conducive to a well-regulated metabolism. On the contrary, it is apt to leave undesirable surpluses of metabolism, which, acting as impediments and encumbrances, provide the soil for infection. The glands, being irregularly and promiscuously supplied, are rendered prone to glandular anarchy rather than to harmony; and, in the absence of harmony, we have a house divided against itself, a house liable to weakness and decay.

Whilst the honey-bee, with only occasional back-sliding, is remarkably immune from the attacks of the highly parasitic *Strepsiptera*, other more pronouncedly predaceous hymenopterous insects, such as the wasps (the highwaymen amongst hymenoptera) and wild bees are constantly liable to be "stylopised" by these vile parasites.

Anti-social behaviour may thus be seen to meet with natural "disfavour," natural checks, and natural "penalisation." The reason, ultimately, is this, that it is irreconcilable with the wholesome socio-physiological progress of the world.

Nearly all parasites have their hyperparasites, and, as a general rule, the preying organisms are constitutionally weaker than the strenuous and co-operative ones.

An important application of this principle is made in scientific agriculture. The sterilisation of the soil is based upon the fact that the predaceous and parasitic organisms in the soil are less viable and less resistant than the co-operative "labour-never-shirking" organisms. We destroy the miscreants by exposing them to the glare of sunlight.

Although this may be said to be a "penalisation" by the agency of man, it is natural "penalisation" none the less; for man is a part of nature. He is, in fact, the conscious partner of the useful plant. And his true office is, manifestly, to encourage the "good" organisms and to discourage the "bad": to make the world safe, if not for democracy, at any rate for righteousness.

An old medical maxim runs that *Pathologia Physiologiam illustrat;* and similarly the case of the "felonious" bee affords negative evidence of what a normal relation between organism and organism should be and very generally is. The norm of relations between plant and animal, for example, is one based upon widely useful mutuality.

Plants and animals are co-evolved beings, and their normal mutual relation is not widely dissimilar to that normally prevailing between the sexes. Actually, the more there is of mutual aid and mutual forbearance between plant and animal, and the more such relation avails towards life generally, the more there is of wholesome co-adaptive evolution. It is a significant fact that the status of a plant is the higher the greater its output of widely useful substances. And this output is in turn proportionate to the counter-services received by the plant from the animal.

The fact that pain and disease always follow the habitual exploitation of a plant is another indirect lesson in normality of relatedness. There is, indeed, overwhelming evidence to show that it

makes the utmost difference in evolution whether a species takes its "remuneration" from the hands of the willing plant, or employs stealth and murder.

The plant is the fundamental provider of organic life, and it is not without the means of self-defence and of reprisal against over-exploitation, as witness the spines and alkaloid poisons, the latter being of appalling efficacy in the physiological economy of the animal.

The reaction of the plant against animal predacity is often quite specific. Vegetable products which are non-poisonous to some useful animal, are frequently poisonous to a highly predaceous one. These must be viewed as indications of how fundamentally order and government are striven for by Nature.

A plant-assassin, of course, may be said to defeat its own ends by stupidly crippling its erstwhile biological partner, which it should aid and compensate rather than injure. It foolishly endangers its own livelihood and is obliged eventually to be content with inferior fare.

Quite unavoidably, moreover, it has increasingly to endure the antagonism of the better disposed and more "prudential" species, which, living as they do, in close partnership with the plant, and thus attaining to a higher mentality and to dominance, are very formidable enemies. The wild boar, as an instance, preferring the fruit of oil-palm trees, kills the trees with its tusks. Hence it is noxious not only to plants, but likewise to man. In Sumatra, man may league himself even with the tiger, which likes wild boar meat better than any other, in order to keep down this plant-destructive pest.

Unfortunately, the prejudice that every animal is a typical Cain has been widely spread. Instead of which it is true that large numbers of insects, birds, and mammalia do not devour or destroy their food-plants, but take only small portions such as can well be spared by the plant in exchange for services.

Darwin declared that we are as yet "profoundly ignorant" regarding the mutual relations of the inhabitants of the world. He also insisted, what is

only too true, that it is this ignorance, more than anything else, which has impaired the complete estimation of the evolutionary process. His very definition of "the struggle for existence" includes the all-important factor of "mutual relations."

It follows therefore that this formula is based on partial but ostensible nescience. What are we to think of the adequacy of "Natural Selection," which in its turn is based upon the misconceived "struggle for existence"?

The weakness of Darwin's theory consists precisely in this inadequate apprehension of "mutual relations." It recognises only local "profit," merely expedient usefulness. Darwin admitted, on the other hand that, "if a little pollen were carried, first occasionally, and then habitually, by the pollen-devouring insects from flower to flower, and a cross thus effected, although nine-tenths of the pollen were destroyed, it might still be a gain to the plant to be thus robbed."

To sacrifice some pollen with consequential good effects, namely, the production of more and better pollen, is a totally different thing from the plant having to endure unrequited theft of substance, which may spell retrogression. We must amplify Darwin's remarks by stating that the healthy progress of the organic world is regulated by a socio-physiological principle of *do ut des*, compliance with which involves wholesome activities and progress, whilst non-compliance involves ultimate loss of life.

Temptations to substitute short cuts for honest labour are, of course, always present; and hence the number of species which have failed adequately to comply, or which have but partially complied, with this principle is legion. Broad is the way that leadeth to destruction, and narrow is the way which leadeth unto life.

Many failing species have carried on by using up their reserves, their patrimony. They have pursued a course of life which brought present success with future ruin. They finished by reaching the stage of extinction, another phenomenon which greatly puzzled Darwin.

Yet on at least one occasion Darwin shrewdly surmised that liability to extinction may be due to "lack of improvement according to the principle of the all-important relations of organism to organism in the struggle for life."

Evidently the defunct species had transgressed against organic sociality.

Modern thought has been grossly vitiated by the fallacy of viewing degeneration as "useful" simplification—a view which would make the intestinal worm or the liver-fluke the peer of the philosopher.

Seeing that Darwin has excused himself with regard to "mutual relations," on the score of ignorance, and remembering that "Natural Selection" is based upon this partial ignorance, we must *a fortiori* reject Darwin's standard (if any) of improvement. We must insist on a saner scheme of organic sociality than that implied by "Natural Selection."

It is a broad and outstanding fact of Palæontology that puny races have survived and monstrous races as a rule become extinct. It is not all the members of a race that increase in size; some remain small until the end, but they survive long after the others are extinct. The condition of monstrous types is sometimes referred to as that of "over-specialisation"; and it is said of them that they were accustomed to live in luxurious indolence. Such were the giant Pterodactyls of the Cretaceous period, the colossal Dinosaurs of the Upper Jurassic and Cretaceous, and the large mammals following them.

In Nature, as in human society, idleness and luxury put an end to many virtues and to health. That "over-specialised" are in reality moribund types is shown by the presence of numerous important stigmata of disease. The symptoms, for the most part, come under the head of acromegaly or giant's disease; and it is plain from many indications that the incriminated species or genera are characterised by pronounced predacity, directed either against plants or against their own animal kin.

According to Dr. Rene Larger, a French exponent of acromegaly, this disease may "attack" not only individuals here and there, as among mankind, but may break out in a whole species or genus, so that all individuals become affected, at first with a moderate degree of acromegaly, but finally with an unrestrained access of gigantism, in which condition the whole race or family finally perishes.

Acromegaly is largely a matter of deformity and of hypertrophy of parts of the body. We may take, as extreme examples of such affliction, the tusks of the *Proboscidea*, such, for instance, as the elephant—a typical acromegalic animal in a state of hopeless senescence verging on extinction.

It is an error, as Dr. Larger states, to think that the approaching extinction of the elephant is due to the action of man. The truth is that elephants are disappearing because they are in the first place considerably impoverished by degeneration, as proved by the presence of the anatomo-pathological lesions of acromegaly. Were it not for this fact, man's agency in destroying these beasts would not have so great an effect. If elephants were normal animals, the fact of man's hunting them would have but negligible effects, as in the case of rabbits and rodents in general. But animals of the family "elephas" are *not* normal; they are, on the contrary, abnormal and acromegalic.

What is specially important, however, although far too little understood, is the fact that the inordinate development of the incisors is connected with the use to which they have been put during long ages. And this use was an anti-social use. It was, in fact, misuse—a term which I have endeavoured to get recognised over and above mere "use and disuse."

The misuse, in this instance, was that incidental upon plant-murder. The hypertrophied teeth, that is to say, were used to uproot trees and to destroy roots and branches; and this constituted a serious outrage in organic sociality; for trees are generally highly useful and have the highest claims for toleration.

The tusks may not be too large in relation to the size of the elephant, but they are certainly too large relative to that of normal animals, and this is bad enough. In biological, as in human, society, it is only in genuine service that there can be true usefulness with consequential health. The service and the "tool" must avail towards life generally; and, in this essential, the incisors of the *Proboscidea* have miserably failed. The whole order has, in fact, reached a blind alley of evolution, as a result of their extensive plant-assassination.

According to Lankester, what proved fatal to the elephant since man took charge of the world, was that the elephant required too much food and that it is only in countries where there is a super-abundance of forest in which it can be allowed to grow to maturity at its own "charges" (so to speak) that it is worth while to attempt to domesticate and make use of it. It is thus the wrong appetite that produces anachronisms.

We have seen that amongst the *Suidae* the wild boar, with its hypertrophied canines, has descended to the level of a rank plant-murderer.

Dr. Larger demurs to the usual argument that the "over-specialisation" of the teeth should be accounted for as an adaptation for defence, although, of course, if it comes to battle, anything and everything may be used. But when, ignoring organic sociality, he confounds the destructive instruments of the plant-murderer with the useful implements of the agriculturist, I must equally demur. If the instruments are not "arms," they are certainly not agricultural implements. At least they have ceased to be such, and form part of the arsenal of robbery. Here, as elsewhere, the robber's utensils are but "variations" of once useful articles.

What is true of the family "elephas" applies with equal force to the apes. The gorilla gnaws great pieces out of the trunks of trees in order to get access to the pith.

In an article on "The Evolution of Man and his Mind," *Science Progress*, July 1920, Major Thomas

Cherry, M.D., quotes Du Chaillou's *Equatorial Africa* concerning this habit of the gorilla as follows: "Here is probably a purpose of that enormous strength of jaws which seemed to me to be thrown away on a non-carnivorous animal."

Here, we have an important lesson both in "parallel evolution" and in comparative pathology. Throughout the animal kingdom the mouth-parts show, broadly speaking, a development depending upon the nature of the animal's food and the method of taking it. As Prof. F. Wood-Jones, the anatomist, says in *Arboreal Man*, "A mouth merely adapted for the reception of food already grasped and brought to it is a structure very different from a mouth adapted for the purposes of reaching out for food, seizing the food so reached, and subsequently dealing with it."

The former condition is fulfilled in the case of an animal feeding upon fruits and berries together with portions of vegetables; whilst the latter condition obtains in a carnivorous or plant-assassinating beast, grasping and "handling" its ill-gotten food with its terrible snout or tusks or jaws.

In speaking of the "recession of the snout region," as important in progressive evolution, Prof. Wood-Jones tells us: "The food-grasping power of the primate hand renders unnecessary the development of grasping lips and a long series of grasping teeth."

This is most marked in the absence of carnivorism or of plant-assassination; and it shows that nothing impairs success in evolution more than predacity.

The highly injurious reactions, correlated with pronounced plant-assassination, extend beyond the mouth-parts and it is vitally important to recognise this. The aforesaid habit of the gorilla, according to Dr. Cherry, accounts for the large bony ridges on the skull, the early closing of the sutures, and the great spinous processes of the vertebræ of the neck. In order to wrench off the pieces of wood, the immense muscles have been developed and lead to "the almost total absence of the

neck, which gives the head the appearance of being set into the shoulders."

Now in this virtual disappearance of the neck we have, in my opinion, an important indication of disease. Dr. Larger rightly mentions it under the symptoms of acromegaly. It is a common mark of inferiority and degeneration. Like gigantism, it is to be found amongst all animals, vertebrates as well as invertebrates, from the gorilla to the Foraminifera.

The elk, or moose, is said to be remarkable among deer for its short neck; and, when we come to examine into its feeding habits, we find that it is a very destructive animal in the forest, rearing up on its hind legs to eat off twigs growing high up and "riding down" young trees by straddling the stem and pressing them down till it can reach the crown.

The elk is further marked by a characteristic encumbrance, a hair covered pouch hanging from its throat, the use of which is said to be quite unknown. The animal is acromegalic and verging on extinction.

From his study of malformations and anatomical peculiarities, Dr. J. Bland Sutton has expressed the view that disease may frequently be regarded as exaggerated function; but a further recognition seems unavoidable, namely, that such function is very generally connected with anti-social behaviour.

Dr. Larger refers to the disappearance of the neck as the tendency of acromegalic animals to become "pisciform," and, since it is my view that disease originates with predacity, causing a "parasitic diathesis," it is significant in this connection to note that the identical symptom characterises also rank parasites. It is to be found amongst such exceedingly parasitic insects, as the *Strepsiptera*. Once these have chanced upon a "suitable" host, they may not only lose their legs and eyes, but the segments of the head and thorax fuse so as to produce a grub-like ("pisciform") appearance.

Dr. Cherry does not omit to note that the habit of the gorilla in attacking trees, apart from the aforesaid anatomical changes, brings in its train important

changes in the blood-supply (at the expense, we may take it, of brain development).

Strangely enough, he thinks that the gorilla's felonious food-getting constitutes "honest" hard work.

He has evidently not yet freed himself from the narrow utilitarianism of Darwinian biology, although he elsewhere declares that the "simple" formulæ of Darwin and Wallace are now considered obsolete.

It may here also be noted that as regards the elephant, the African species, showing plant-depredation more pronounced, are also more strongly marked by gigantism than the Indian species. Whilst the African elephant, for the most part, occupies itself in tearing up roots as thick as a man's arm, which it chews for the sake of the bark and sap, the Indian has accustomed itself to a finer diet, for its feeds on grass, the young shoots of the bamboo, leaves and fruit of the plantain, fig, and jak trees. The tusks carried by the African species are much larger than those of the Indian, and, unlike the females of the Indian animal, the tusks of which are very small, and hardly protrude beyond the jaws, the females of the African continent carry tusks that average from 10 lb. to 14 lb. and in some cases are heavier.

As regards general shape, the African elephant carries its shoulders at the highest point, which gives the appearance of a back sloping towards the hindquarters, while the Indian species has the back arched, the hindquarters being higher than the shoulder. That is to say, the Indian elephant, which is capable of being tamed and domesticated, has a neck, and even a depression in the neck, for a seat, whilst the African, the more typically ferocious and monstrous beast, is neckless.

We find the sequence everywhere to be much the same; and our verdict must be that the "work" of plant-assassins, however hard, is none the less "dishonest." It does not make for harmonious constitutional development, because it represents energy misdirected—felonious biological function leading to exaggerated physiological function.

Physiological harmony (health) is thus interdependent with biological harmony (perfect sociality).

In keeping with Darwin's hypothesis of Pangenesis, which, though at first denounced, is now, in a somewhat modified form, commending itself rather more than that of "Natural Selection," we may view the organs of the body as semi-independent organisms. They are allied, it is true, in a very intimate form of co-operation. If, however, they fail duly to co-operate, if any are prone, in the words of Prof. A. Keith, "to seize more than a fair share of the manna in circulation," or to have "sticky fingers" and "seize what is not really intended for local consumption," then disease inevitably ensues precisely as it does with failing co-operation between animal and plant on the grand scale of Nature.

Nature knows no watertight compartments; and the various spheres of biology may constantly be seen to overlap. So much is this the case, that it may be said that organs and organisms are involved in a common sociality, are jointly and severally under a basic law of concord. That is to say, that the secret of health and success in evolution lies in dutiful compliance with a law of cosmic co-operation. We may thus look forward to the approaching consummation of a prophecy of Sainte-Beuve, depicting "un avenir dans lequel les lois de la physiologie seront transformées en lois sociales et inaugureront dans le monde le régne de l'harmonie universelle."

"Man," says Dr. Cherry, "has become lord of all because he never had great canines."

I should say that man's status is incompatible with that of a pronounced plant-murderer. He has preserved, what is required by his status, a happy mean of appetite such as is most consistent with the performance of patient and systematic services and duties in organic civilisation.

Man's organisation is the least adapted for "killing" and it is the adaptation of the mouth for "killing" which, according to Prof. Wood-Jones, constitutes a complicating factor of evolution. According to this

anatomist, it is the distinction of the human stock that it never became the slave of its arboreal environment, " for it became adapted to tree-life in a strictly tempered manner, and it specialised to the successful minimum degree." The word " successful," of course, begs the question of normality of specialisation. But, in the light of the foregoing, it is pretty clear, I think, that man, in order to achieve the success of which he may justly be proud, had all along to be a tolerably austere and virtuous being.

And this is more than can be said of the felonious and parasitic insect, of the elephant, the boar, the elk, and the gorilla.

The danger of plant-assassination on the part of man was strikingly illustrated by a paper on " Forests and Fertility," by Colonel Haig in *Discovery*, May, 1923. The writer points out that the inconsiderate destruction of trees by man has been attended by baneful effects on the climate and the resources of the region in which he lives. Where mountains and uplands have been denuded of their forests, the results have been destructive floods in the rainy and shrivelled up rivers in the dry seasons. Subsequently, as stated by Colonel Haig : " It usually happens that when a country is deforested, goats and camels are turned on to the land. Any live roots are speedily grazed out of existence, seedlings are destroyed, and the humus pulverised and scattered. Then the replanting is a difficult and expensive job."

The term " plant-assassin " has been derided by some biologists, just as the concept of Symbiosis was at first received with indignant scorn. The appropriateness of the term " plant-assassin " was, however, forcibly brought home to the public quite recently when Mr. R. St. Barbe Baker, the founder of " The Forest Scout " movement of Kenya, reported the case of the Kikuyu tribe, which had actually got the name of the " forest-destroyers."

" Whenever they wanted to make a fresh cultivation, they went into the virgin forest, cut down and burned off the trees, and then planted their seeds. They would

stay here until they had reaped two crops, and then they would abandon the old cultivation and proceed to take up more land, until the whole countryside was becoming denuded of trees" with the usual calamitous results.

Now, under the guidance of Mr. Baker, a movement called the "Men of the Trees" has been formed, consisting of thousands of East African negroes. "Two years ago they were destroying the forests at an appalling rate. To-day they are protecting them with all the stubborn determination of their race, and, what is more, these unlettered savages have actually started a system of afforestation without costing the Government one penny in wages or payment."

The Forest Scout movement has become an important contribution to the Empire.

CHAPTER VI.

Symbiosis before the British Association.

"We have no reason to exclude the animal world, or even the vegetable kingdom, from the working ofa process familiar to our own experiences." *Prof. Fournier d'Albe.*

Professor G. H. F. Nuttall is a great parasitologist. He is M.D., Ph.D., Sc.D., F.R.S., as well as Quick Professor and Director of the Molteno Institute for Research in Parasitology at the University of Cambridge. He is also Editor of several scientific journals. He spoke on "Symbiosis in Animals and Plants," as president of the Physiological Section, British Association, September 13th, 1923.

In a brief abstract of his paper, *Nature,* September 15th, 1923, states that "the subject is one of broad biological interest—an interest that should appeal equally to the physiologist, pathologist, and parasitologist. It is a subject on which much work has been done of recent years, and information relating thereto lies scattered in the scientific literature of various countries. The term Symbiosis denotes a condition of conjoint life exitisng between different organisms that are benefited to a varying degree by the partnership."

Here, then, we get the orthodox definition of Symbiosis. The wider view, for which I have contended for some years, is ignored. The specialist's point of view is upheld and it is not even deemed worth mentioning that a more comprehensive view exists. Let us look a little closer at the above definition of Symbiosis. It is very anæmic. Partnership crops up only incidentally, and at the wrong end of the stick. It

wears a rather bedraggled appearance. Chief stress is laid on the mere physical fact of attachment—the paltry factor which Symbiosis and parasitism have in common —whilst the vitally important distinguishing factors, recognition of which would mean emancipation of Symbiosis from the clutches of the mere parasitologist, are omitted or slurred over. We are to understand that Symbiosis is never very far removed from parasitism, and that what partnership there may exist is not a real thing but a kind of mimicry by Nature of human institutions —as though Nature, in order to discover an economically sound way of association, has had to wait and then to copy and imitate the methods of man. One practical effect of making Symbiosis a mere variant and outcome of parasitism is to be rid of the task of having to take account of the sociological and socio-physiological implications that the case presents. Because this is an uncongenial undertaking to laboratory men, we are to be deprived of the very essence of this most important phenomenon, which in its bearing on human happiness is second to none. Another deplorable practical result is that only dubious and primitive cases of partnership are to be recognised as Symbiosis, and this must cause a bias in the student at the very start. Only such cases of "conjoint life" are to be denoted as Symbiosis as easily grade into parasitism. It is as though, because the health of some human stocks is so low as to approximate to disease, we must jump to the conclusion that all health is but a benign form of disease. Strictly speaking, in the sense of the above definition, Symbiosis is no more than an occasional benign form of parasitism —a kind of crypto-parasitism, whilst the more malign form might correspondingly be termed gymno-parasitism The use of these expressions would concede some cases of "intra-cellular Symbiosis" to the parasitologist and release the term Symbiosis for cases of genuine partnership, such as the reciprocal relation between flower and bee, tree and mammal, for instance, which Professor Nuttall has quite overlooked. I claim that Symbiosis should not be limited to intra-cellular

relations and that the definition which I have introduced of Symbiosis and of parasitism respectively are fair and adequate to meet the case. By Symbiosis I mean systematic biological co-operation, recognisable by reciprocal differentiation serviceable to both partners. By parasitism, on the contrary, I mean the antithesis of such reciprocity, namely, one-sided exploitation of organism by organism.

A large part of the criticism applicable to Professor Nuttall's paper I have forestalled elsewhere. Much may, therefore, be passed over, whilst the case of orchid-cum-fungi Symbiosis, with which the paper deals at some length, is treated much more fully in my book on "Symbiosis: A Sociological Study of Evolution." It was Schwendener's view, apparently, that the fungi are parasitic on the algæ in lichens. This was contested, as we are told, by Reinke (1873) on the ground that a state of parasitism did not explain the long and apparently healthy life of the associated fungi and algæ. We are told that "we may find in lichens the condition of true Symbiosis on the one hand, ranging to demonstrable parasitism on the other, and, conversely to what has been described above, instances are known wherein algæ are parasitic on fungi."

The relation of Symbiosis to parasitism is thus much the same as that of health to disease amongst men: we may find the conditions of true health and of true disease, and though they be not always clearly distinguishable, yet they are two different and opposite conditions. That algæ may be found parasitic on fungi, and *vice versa*, only shows the universality of the disposition to short cuts, it does not prove that short-cuts mean sound economics, or imply permanence of association. We are told that "the nutrition of algæ in lichens is similar to that of other chlorophyllaceous plants," which is a tribute to the normal non-parasitic character, at any rate of the lichen-alga, which has remained in the main, strenuous, industrious and synthetic. Treboux (1912) regarded the algæ in lichens as the victims of parasitic fungi, but Chodet (1913) contended that the

algæ obtained from the fungi-hyphæ both organic nitrogen and carbon in the form of glucose or galactose, thus contradicting Treboux, since there is obviously give and take in the relation, which is more than parasitism can boast of. We get a summary of Moreau's view (1922): "The lichen-fungus appears as an organism characterised in its morphology by deformity due to an infective agent, an alga. The history of the association existing in lichens may be described as that of a contagious malady marked by the invasion, development, inhibition, and death of the infective agent on the one hand, and on the other hand by the morphological reactions and defensive processes of the attacked organism. In conformity with the virulence and relative immunity of the two opponents, the struggle may be short, the association transitory, the conflict may last indefinitely, and the association, rendered lasting, presents the appearance of a harmonious symbiosis."

This is merely defining in terms of disease and of warfare what would be better defined in terms of health and of division of labour. Alas, even in human society, the mutual accommodation of individuals, or of individual classes, or groups, proceeds usually with intermittent friction, although this does not by any means preclude a fundamental co-operation. A struggle which lasts "indefinitely" is a very problematical thing. Who is to pay for it? Montecuccoli knew that to carry on warfare for any length of time (however much European males delight in it) requires money, *i.e.*, honest earnings. In other words, someone has to slave and to save. The subsistence has to be got somewhere by honest labour. Warfare exhausts what co-operation has built up. An "association rendered lasting" under an "indefinite conflict," and presenting the appearance of a "harmonious symbiosis," is in reality a co-operative association, though it be attended by occasional friction. It is an association in which a useful reciprocal differentiation proceeds below the surface of the struggle, which is the opposite of what

takes place in parasitism, where the struggle is real and fatal, with co-operation only apparent. Biologists are still morbidly afraid of taking a generous view of Nature. Hence we are asked to believe that, despite mismanagement, things may terminate well, which is a delusion. A long-protracted conflict, such as is witnessed in parasitic relations, can never end satisfactorily, however the appearance may be to the contrary. Such an association is marked and marred by morbidity, a morbidity which extends to both partners. In the symbiotic relation, one associate may at times feel morbidly and parasitically inclined; but it is the beauty of a truly symbiotic relation that the righteous disposition predominates and that the other parts are capable of supplying wholesome control. When parties are associated for widely availing service, they are also under many wholesome controlling influences, tending to keep them to the path of duty—minor lapses notwithstanding. It is the predominance of the co-operative disposition which constitutes the symbiotic relation; it is the predominance of the opposite disposition which constitutes the parasitic relation.

From Professor Nuttall we get an interesting demurrer. He objects to bacteriologists "continuously misapplying the term Symbiosis in referring to bacteria grown in mixed cultures, when there is no evidence whatever that the micro-organisms are mutually interdependent for the growth." This points in the direction of discrimination. I have always demurred to the misuse of the terms Symbiosis and parasitism. It is all-important that we should have a reliable line of demarcation between Symbiosis and parasitism and any attempt in that direction should be eagerly welcomed. We are further told by our parasitologist: "Geddes found that animals harbouring symbionts are much more resistant than those without symbionts," whilst Brandt believes that symbionts and host aid each other in nutrition. All of which shows that, as I have stressed, Symbiosis is in the path of health, whilst parasitism is in that of disease, and, that, ultimately,

Symbiosis involves nutrition, the crux of the whole matter; wherefore it is true that without a thorough understanding of the laws of nutrition, the elucidation of Symbiosis is quite impossible. The use of the term "host" is, of course, quite illegitimate in this connection, although Nuttall upholds it as "convenient" and "in conformity with parasitological usage." Further we learn: "Using modern methods of gas analysis, Trendelenburg (1909) concludes that green Actinias (*Anemonia sulcata*) live in true symbiosis with algæ, the algæ supply oxygen to the animal by day and at night utilise the oxygen evolved, whilst carbon dioxide is furnished to the alga partly by the animal and partly by the water in which they are bathed. Rutter (1911) studied the nitrogen metabolism and concludes (a) that the Actinia yields to the algæ nitrogen in the form of ammonia for protein synthesis, and in darkness it adds carbon-containing substances (nitrogen-free), whilst (b) the algæ yield to the actinia nitrogen substances in the dark and by light carbon-containing substances."

With "modern methods," then, we begin to discover that in Symbiosis we have a case of genuine healthful partnership, based on a reciprocal differentiation similar to, and the same in principle as, that obtaining between the parts of the individual body—a partnership of which parasitism is the direct reversal. Daily and nightly the mutual support goes on, so profound is the partnership, the reciprocity to which we are here introduced.

It is quite evident that the matter of reciprocal differentiation is insufficiently understood. Thus in the case of "embryonal infection as in parthenogenetic Aphids" (which harbour symbionts) we are told: "It is difficult to understand the mechanism whereby the symbionts penetrate the egg in the insect's body; in any case the complicated procedure must depend upon a mutual and parallel adaptation of the insects and micro-organism concerned." We shall never know enough about "mechanism." It is ever elusive and imponderable. Whilst we chase it, Rome burns. The mechanism

will take care of itself, as I have often pointed out, so long as organisms continue duly to co-operate. Even if we knew all about the mechanism, this would not alter one iota of the fact that the quality of the mechanism depends upon the quality of the co-operation. The learned parasitologist tells us further : " We know little regarding the part played by symbionts in insects ; our information relates almost exclusively to their morphology, mode of multiplication, and entry into the host during its development. There are no indications that the symbionts are injurious or pathogenic. It is evident, however, that they find in certain insects favourable conditions for growth, multiplication, and transmission from host to host. In these cases, therefore, we are dealing with a constant very harmonious association which excludes even a suspicion of there being any conflict between the associated organisms. We may well ask ourselves what are the reciprocal advantages of this association, but this is a question that it is impossible to answer in view of our ignorance of physiological and biochemical processes in insects."

The very suspicion of conflict now vanishes into thin air. The whole case for parasitism is thus given away with the admission that what is most worth understanding, namely, the reciprocity, is not understood. It is evident, therefore, that, in reality, Symbiosis is still a puzzle to biologists. What is all-important to know is this : what are the conditions which promote wholesome and widely availing mutual accommodation amongst organisms. These conditions I have set forth clearly in my various writings so that he who runs may read. Biologists are apparently waiting to " rediscover " my discoveries. If we are ignorant about physiological and bio-chemical processes in insects, we know at any rate that insects maintain, as the norm of life, most important relations of Symbiosis with the world of plants, and here, as I have frequently emphasised, it is those adapted to appropriate feeding habits, to ideal forms of mutual accommodation, namely, the " cross-feeders," which excel in all important particulars. It is with Symbiosis

as with art or with science. If one would succeed, he must devote himself thoroughly to the task, including sacrifice of the appetites. You cannot have it both ways in matters of feeding as a symbiont. Otherwise it would be true that things may be long mismanaged with impunity. Unless it is clearly realised that the mutual accommodation of beings involves a definite rule of nutrition, there can be no understanding of Symbiosis, or, for that matter, of parasitism either. Erudite though it be, Professor Nuttall's paper is marked by uncertainty and by lack of grasp of principle. He is too apt to lapse into the general error of biologists to dub almost any and every form of conjoint life "parasitism." This error is partly the result of a facile tradition. The error was pardonable so long as "mutual relations" remained unelucidated, so long as an opposite relation to parasitism was undiscovered or unrecognised. It has been stated that we should not know what good is, if we did not know evil, and the converse is also true. It was pardonable if Darwin and his contemporaries misapprehended parasitism. It is less so to-day with what has come to light concerning Symbiosis. Biologists have yet to learn that there has to be law and order in matters of mutual accommodation, as in those relating to nutrition; that things refuse to be mismanaged long; that economic laws pervade the universe as eternally as Nemesis keeps watch, refusing to let any wrong go unchastised. They had been led to think, on the contrary, that one can do wrong without suffering wrong (based on which gospel they would fain often prove themselves in the right by the method of suppressing others). They were taught by those who possessed only half-knowledge of the methods of Nature that the "struggle for existence" alone counted, and that the way to get on, as exemplified by Nature, was merely by expedient methods, merely expedient adaptation. But the world refuses to stand still at a biologist's word. *E pur si muove.*

I would here append the remarks of a critic of mine in the *Manchester Guardian*. In his perplexity about the

exact form of our right compliance with the demands of Symbiosis, and in his reluctance to recognise Symbiosis as a universal principle, he finishes by condemning what he yet had to concede to be in large part admirable. This is what he says: "In current biological thought evolution no longer signifies the survival according to their value, of casually arisen variations; most of us implicitly or explicitly have come to believe in an evolutionary plan, but have hardly sought an aim for the plan beyond creation as we see it, still less a dominant idea underlying the plan. The mind is forced to look outside casual variation, but has generally rested, perhaps with an increasing vagueness, on the idea of survival value as something limited to the individual or the species. It is Mr. Reinheimer's achievement to interpret survival value in terms of value to the plan, and its efficiency in terms of conformity with what he believes to be the dominant idea behind it. As a biological philosopher he at least attempts what we believe to be a fresh generalisation. The view of creation is a quasi-moral one, in which the biologically good, being in accordance with plan, survives, while the biologically bad is marked down for biological misery and ultimately for extinction. The criterion is the idea, symbiosis, in the author's meaning of the term. By this is to be understood, not parasitism, not commensalism, but definite, we had almost said deliberate, mutual adaptation for the purpose of mutual service, on the part of living things not organically or permanently associated, and nearly always of different orders of creation, broadly, that is, between the plant and the animal. To the push, as it were, behind the process, the urge behind the plan, he gives the name symbiogenesis. Now in this we at once confess that we have a conception illuminative over a large section of the evolutionary field, and, once pointed out, its neglect by past thinkers is almost startling. The substitution for survival by struggle of survival by co-operation justifies itself as obviously applicable to a wide field of co-ordinated structures in plants and insects, where the animal is sustained by the

surplus anabolic production of the plant, rendering in return, invaluable services in the fertilisation, especially the cross-fertilisation, of flowers. It is applicable, however, only in a small degree to the case of vertebrates, the fruit-eating birds and bats being almost the only effective instances of anything approaching such a relation, and it becomes almost inoperative, so far as we know, in the vast domain of aquatic creatures. Here we are face to face with one of the stumbling-blocks."

There is no stumbling-block whatever, except in the imagination of the critic. Those organisms, be it on land or in the water, which have excelled in Symbiosis have prospered and progressed, whilst those that have divorced themselves from Symbiosis, have declined. The "applicability" of the principle is not to be measured by the extent of the existing divorce from Symbiosis at any given time; it is to be measured by the actual achievements of Symbiosis at all periods of evolution, of which achievements the critic, owing to the narrowness of his outlook, and owing to prejudice, entertains but an insufficient estimation. I venture to predict that "Symbiosis" will vindicate itself triumphantly against all detractors.

CHAPTER VII.

Professor Thomson's Criticism Answered.

"Nearly all really new ideas have a certain aspect of foolishness when they are first produced."

"The world of science has always remained completely satisfied with its peculiar abstractions. They work, and that is sufficient for it."

"The point before us is that this scientific field of thought is now, in the twentieth century, too narrow for the concrete facts which are before us for analysis. This is true even in physics, and is more especially urgent in the biological sciences. Thus, in order to understand the difficulties of modern scientific thought and also its reactions on the modern world, we should have in our minds some conception of a wider field of abstraction, a more concrete analysis, which shall stand nearer to the complete concreteness of our intuitive experience. Such an analysis should find in itself a niche for the conceptions of matter and spirit, as abstractions in terms of which many of our physical experiences can be interpreted."

Dr. A. N. WHITEHEAD in *Science and the Modern World.*

Since I wrote the foregoing chapters there has appeared a review of my book "Evolution Re-Interpreted" in *John O' London's Weekly,* by Prof. Thomson, in which Darwinian sophistry is shown at its worst.

The professor, who usually assumes the *pluralis majestatis,* and who, with his great powers of exposition and of popularising science, has attained to a somewhat exaggerated position of authority, has of course never found it worth while to acquaint himself with the mass of collated evidence accumulated in support of my views. With him, moreover, as with many of the general public, "Natural Selection" has obtained so uncanny an ascendancy that he cannot think in any other terms. Constitutionally, he cannot but construe any and every

kind of biological argument as of necessity proving "Natural Selection." Replete with learning he is, but lacking in originality.

He protests that Darwin's "struggle"—which he says I am proving—includes all the efforts of the organism to secure the welfare of its family, and, among gregarious and social animals, that of its kindred. Granted, but the co-operation to which I call attention is of a much broader kind, including the mutual interests of different species, and principally, and in the last analysis, chiefly those of such opposites as plants and animals, involved as these are in a scheme of bio-sociality and of co-evolution. Of that scheme we find no mention, but, if anything, only repudiation in Darwinism.

I fully and gladly concur that Darwin has been the great pioneer to discover facts illustrating interdependence of life, and, if Prof. Thomson had merely said that I was building on Darwin, but was giving a distinctly new, a pronouncedly bio-moral and bio-social, turn to the interpretation of the facts, Darwinian and others, subsequently discovered, I should have taken more legitimate pride in the honour which (despite some detractive criticism) he wishes to confer upon me in hailing me, as he does, as a brother-Darwinian, stating that I had "helped sound Darwinism." It may be that, in a sense, I have done so, but before any Darwin medal is conferred upon me, I should like the public clearly to understand in what exactly my merit consists, for I am constituted in such a way that I cannot be content to base my life on falsity or to be wearing sham laurels.

Prof. Thomson states that I have been an unconsciously loyal disciple of Darwin in emphasising the importance of inter-relations, but that "unfortunately" I am applying to these the "pre-occupied" term—Symbiosis. I venture to think that even Prof. Thomson, hard-shell Darwinian though he be, if he had sufficiently acquainted himself with the powerful reasons that I have adduced for rejecting the orthodox "pre-occupied" conception of Symbiosis, and of applying that term differently from the schools, he would see his way to

make some apology in his criticism. In any case, I venture to predict that even what I have to say in the present volume in justification of my departure from orthodoxy will be sufficient evidence to unbiassed minds, to establish the fairness of my position.

Although Darwin, meritoriously, and as a pioneer, established numerous facts of inter-dependence, he could do no more than place a kind of naturalistic or hedonistic interpretation on them, one that is irrespective of bio-social and bio-moral values. Indeed, as we shall presently see, a bio-moral interpretation was virtually repudiated by Darwin, and this it is which constitutes the chief point of difference between us. Let us see.

The teaching of "Natural Selection" involves what is known as the theory of "digestive transformation." That is to say, it is held that as the strong gobble up the weak they become elevated in type and "transformed" according to progressive evolution. The weak make, it is declared, a "sacrifice," *i.e.*, on the lines of the pitiable slaves condemned to die for the entertainment of others more fortunate in the arenas of imperial Rome—*morituri te salutant*. The utter falsity of this teaching and of its bearings in many important directions was apparent to me from the very moment I began seriously to study Darwin's works, and it constituted so fundamental a difference that I can ill acknowledge him as my master in the sense his "disciples" would have it, and must refrain from prostrating myself before him as Prof. Thomson and his friends would fain require.

Moreover, if I have incurred the displeasure of Prof. Thomson, ostensibly because I fail to speak with bated breath of Darwin, I suspect that there is more behind the wrath, namely, an animosity of the same kind as that which has invariably been poured with great virulence upon pioneers. As Sir Frank Beaman, reviewing my book, stated: "Since the 'symbiotic' reading of the universal evolutionary process violently conflicts with orthodox Darwinian biology, it is not surprising that his opening assaults contained in his ampler works 'Symbiosis,' 'Symbiogenesis,' and 'Evolution at the

Crossways,' met with a rude and discouraging reception in most of the recognised scientific circles. The author was an obscure free lance—a mere laymen—and that was enough in itself to bring him under the scornful lash of accredited science."

Prof. Thomson is, of course, fully aware, that pioneers, biological and medical, have all along been harshly and shamefully treated by the professionals and their parasites; and he might now well bethink himself that the time has come for such iniquity to be ended. But as a good Darwinian, he is probably satisfied that a little (intellectual) murder does no harm so long as it realises a (Darwinian) "profit"—that is a profit to the profession. The teaching of the "struggle for existence" was summarised in the lines of a famous ballad, thus :—

> "Ere Man was developed, our brother,
> We swam and we ducked and we dived,
> And we dined, as a rule, on each other—
> What matter, the toughest survived."

This, says an eminent Selectionist, is true natural selection. In other words, it is a theory of fortuity, of mutual plunder—a theory of unreason—which is nevertheless dinned into our ears by biologists of every description, and, not only by such as these, but, wonderful to relate, also by some of our great modernist divines, who of late years have been so busy coquetting with science and trying to reconcile Darwinian biology wi h Christian ethics, a quite impossible task (although, as Sir Frank Beaman, and others with him, have pointed out, the present writer's "new principle of interpretation removes all difficulties and demonstrates a complete logical reconciliation").

It remained to be seen whether the path of health, fitness, and evolutionary progress was in reality along the lines of "digestive transformation." The proof of that matter would surely have required a previous elucidation of the laws of nutrition and of organic sociality.

But these are precisely the fields which the Selectionist

in his self-sufficiency has neglected, and which, to the schools, have remained a *terra incognita* to the present day. My own gleanings have convinced me of the fallacy of Darwinism on these questions. Contrary to the tenets of the cult, I have found that one-sided exploitation of organism by organism, in whatever form it presents itself, is calamitous to both offender and offended, and that Emerson was right in stating that it is the one base thing in the universe to receive services and to render none in return. Failure of due reciprocity is not only otiose it is also the chief cause of retaliation—a big chapter in life and in evolution—as it is of disease and of elimination. A whole gamut of diseases is engendered by failure to co-operate, as I have often shown, being an illustration of the fundamental fact that things refuse to be mismanaged long. Unbiassed readers will admit that this new teaching to the effect that the divorce from Symbiosis conduces to disease and degeneration constitutes a very wide departure from Darwin—too wide a departure, as Samuel Butler would have said, in his sarcastic way, for a cross with Darwinism to be effected with any chance of fertility.

I am not denying facts of competition and of struggle. I merely affirm, and show, that progress and survival-capacity are fundamentally and pre-eminently maintained by co-operation. One reason why this has not been seen clearly before is that the facts of co-operation are in general less conspicuous than those of competition, and that the world is rather more inclined to be interested in the career of a scamp than in that of an honest toiler.

It has thus come to pass that the seamy side of biology has been mistaken for the norm of things, and the negative factors of evolution for the positive. As Sir Frank Beaman stated, in reviewing "Evolution Re-Interpreted": "In the light of fuller experience and saner thought and bearing in mind the exposure of one Darwinian fundamental fallacy after another, it is hardly too much to say to-day that the whole or almost the whole, of neo-Darwinian biology is concerned with

the pathological phenomena of life without, apparently, any awareness of the possibility that there may be opposed to this set of phenomena yet another displaying bio-social normality and healthy growth. If it can be proved that co-operation and mutual service are indispensable conditions of all genuine evolution and not the jungle law of robbery and murder accepted and justified by Darwinian biology, orthodox science must perforce admit that it stands in need of radical reform."

One finds that so far from showing any willingness to make such admission, orthodox science is on the contrary, evidently, out to besmirch the reformer.

Whilst sneering—with considerable arrogance, be it said, and with an appeal to popular prejudice—at my nutritional theses, which are altogether basic to my evolutionary theory, Prof. Thomson admits that other evolutionists have neglected the study to which I have devoted myself, namely, that of " animal dietetics " and " animal sociology " (although a few have made occasional references to these matters, without, however, enunciating any guiding principles—a few desultory workers in whose company Prof. Thomson bids me take a humble back seat).

He even goes so far as to say : " Now it seems to us a fair thing to say that Mr. Reinheimer is commendably ahead of his time in groping after a socio-biology. That is to say, he has discerned that biology has failed to give satisfactory account of animate nature because it made too little of the social factors involved."

But how is it that biology has failed rightly to estimate the social factor ? Partly because sociological study is not congenial to laboratory men, and partly because Darwin, my " master," whom, I am told, I am " caricaturing," has specially repudiated those very social factors which here count most. And how is it that the great Darwin, whom in other respects I have often and gladly acknowledged my master, has failed in that matter? Largely because he followed a lead from Bismarckian Germany, instead of following his own inspiration, which would have taken him in a different direction. Instead of

proceeding to the establishment of a science of organic sociality, Darwin taught that "Nature cares solely for the good of each being." Few people realise the significance of this tenet, which yet crops up incessantly as an important point of argumentation in Darwinian literature. How is it that this tenet is so indispensable? Because, by way of denial, it conveniently covers the gaping apertures left by the neglect of the study of organic sociality. The achievements of the organism by its own efforts, by its behaviour past and present, and all that it owes to co-operation: all of this is to be covered by the supposition, (the inversion) that it was Nature (the aggregate of forces working round us) which had taken the pains necessary to profit each and every organism.

Sociological study being uncongenial to them, naturalists chose to adhere unprogressively to the convenient formula, "Nature cares"—how much in one case or how little in another, not one troubled himself to investigate. This is where my thesis properly comes in, since I maintain that it is not a matter of Nature's "caring" in a personal and paternal, or rather maternal, way, that determines success or failure of an organism, but the degree of obedience (unconscious, of course) to bio-moral or bio-social laws, which can be ascertained by anyone willing to give a little unbiassed attention to the matter.

These, I believe, are the "mutual relations," the study of which Darwin enjoined upon his followers. The latter, however, partly from disinclination and partly from lack of talent, shirked the matter, preferring instead to express righteous indignation in strident tones at the proceedings of any who have perseveringly advanced science along those lines.

Nature—if there is to be any personification at all—cannot be said to care merely for the good of every creature. She would have to be a compound of pagan deities to live up to that scholastic idea. One would not take such strong exception to this "Nature cares" tenet if it merely stood, as seemingly it does, as a broad

and vague philosophic expression of trust in Nature. But much more than that, a stark sophistry, and in fact an infamous libel of Nature, lurks behind the innocent-looking phrase. As an argument in scientific disquisition it cannot be countenanced at all; it is an afterthought, introduced to justify the way of the ruthless and immoral Darwinian God to men, and at the same time to justify the omission or banishment of bio-sociality and of bio-morality from Evolution. It is amazing that such a postulate could have found wholesale and unchallenged acceptance by men of science. In accordance with this tenet, they have imputed to Nature a narrow expediency, as though she were anxious, in her wanton way, to let the good of individual species take precedence of the good of all.

The organism had but to contract certain habits, in exercise of its choice, be they never so anti-social in value, and undiscerning Nature, so it was thought, hastened to sanction them, the bad equally with the good. A little "disinterested" care of this sort on the part of Nature, if only long enough continued, so it was held, might work miracles, and go a long way to account for the otherwise mysterious superiority of Nature's results over those produced by man in the domestication of species. What is overlooked is that the true antithesis in the production of superior species on the one hand, and of inferior ones on the other, is not between brief care and long-continued care (on the part of Nature), but between right care and wrong care of organism for organism.

Economic laws are eternal. Hence it is that right care, be it in Nature or in human life, is practically identical with co-operation between species and species (Symbiosis), and neglect of care is identical with the opposite methods, namely, unilateral exploitation of species by species. Nature's productions, contrary to Darwin's guesses on the subject, are generally superior to man's inasmuch as they are fundamentally due to co-operation and the avoidance of unilateral exploitation. Man's productions are, on the contrary, inferior, inasmuch

as he exploits too one-sidedly the results of such co-operation.

The acme of Darwin's appreciation of inter-dependence in Nature is usually held to be constituted by his much quoted discovery of the fact that the presence of a feline animal in large numbers in a district might determine, through the intervention, first of mice and then of bees, the frequency of certain flowers in that district. Upon this discovery rests the modern, equally naturalistic, idea of the "balance of Nature." The crops of red clover in New Zealand were failures until bumble-bees were introduced to fertilize them. The nests of the bees however, were raided by field voles, and so the clover crops remained poor. But the crops were good in the near neighbourhood of villages, where the domestic cats killed, but did not eat, the voles. More cats, therefore, more clover; more clover, better and richer pastures, and so a greater production of cattle. All credit to Darwin for having made these valuable observations, which might have led, and should have led, to bio-sociality proper, but they did not so lead; they should also have led to pathology proper, but they failed to do so. For in this mutual devouring of organisms, which is falsely taken as the norm of Nature by Darwinists all the world over, there is the very germ of disease and of destruction. It is now known that a dangerous worm passes a portion of its life in the bodies of mice and another part of its life-chain in the cat, to which it becomes dangerous upon the cat devouring the mice infested by it.

More important still than knowledge of the balance of Nature is the knowledge of the inherent righteousness of Nature which is here involved—a knowledge which even if it did no more than re-vindicate the ways of God to man, would amply repay the troubles of exploration. But such knowledge does more, far more. The nutritional teaching coupled with it, in particular, once duly established, as I am quite confident that it eventually will be, will for the first time render evolutionary teaching pregnant with consequences upon the conduct

of life, so much so that even the revolution which Darwin wrought in men's minds with his "descent with modification," will, by comparison, pale into insignificance.

If I acknowledged Darwin as my master in the matter of "mutual relations," I should, *ipso facto*, be acknowledging myself the disciple of some musty German professors to whose opinions Drawin too uncritically submitted, and this is more than can be demanded of me.

It was under infelicitous German auspices that Darwin averred (rather inconsistently with better inspirations elsewhere), that in the case of the co-adaptation between plant and insect, for instance, since the plant's adaptation was not "exclusively" to the advantage of the insect, it could only be exclusively useful to the plant. Why a co-adaptation should not be held to be of social use to all concerned is difficult to see, except it be desired, at all costs, and so as to bolster up a gospel of war and damnation, to avoid the implication that organisms are linked together in a common sociality, involving bio-social values, just as inter-dependence in the human sphere involves sociological values.

I append here a reply to Prof. Thomson's review sent to the Editor of *John O' London's Weekly*, which, however, he found too long and too technical for his readers, whilst assuring me at the same time that he was entirely unbiassed in the matter :—

To the Editor *John O' London's Weekly*.

"The great stumbling-block to your eminent critic is constituted by my nutritional thesis, *i.e.*, my insistence on the importance of 'cross-feeding' (animal on plant spare products, and plant on mineral substances) in the evolution of the species—a matter which I consider altogether pivotal to the advance of biology. Let me recall the fact that I am an upholder of Darwin's teaching, exemplified by classical experiments, (although even so often questioned by his professed adherents) and embodied by him in the aphorism 'Nature abhors perpetual in-breeding.' I have promulgated the parallel and

cognate teaching, exemplified in a number of volumes, that 'Nature abhors perpetual in-feeding' (like on like). I am bound to demur strongly to Prof. Thomson's *ipse dixit* that I have squeezed to death the evolutionary significance of food. The trouble is that the professor has hitherto been far too little challenged. I know for a fact that he has woefully underestimated the importance of food in his various writings. What has he to urge against my view of the superiority of cross-feeding to in-feeding? An appeal to popular prejudice? Surely this is not good enough, and scarcely worthy of him. Nutrition inevitably involves appropriation—utilisation, that is to say, of earned, or merely borrowed, or stolen, material, as the case may be, manufactured by the industry and the bio-chemistry of other creatures, and most fundamentally of plants. Food-getting involves either a gross one-sided exploitation of organism by organism—a violation of the fundamental sociality of life, as I have shown, or, in the alternative, a harmonious and integrative relation of mutual exchange, of give and take, (Symbiosis), entailing the summation of powers by co-operation, and conducive in the end to exaltation of type—

'Whence pluck they brains
Her prize of gifts.'

Nutrition thus involves (natural) ethics and it amounts almost to wilful blindness on the part of orthodox biology to shut its eyes to this great fact. Here is also involved the understanding, the due assessment of, parasitism, than which nothing could be more important, both from a medico-biological and from a general point of view. The cancer-cell is a parasite and cancer is not understood, because parasitism is misapprehended.

Carnivorism is often but the half-way house to parasitism. Carnivorous habits can only be defended by special pleading, as is illustrated by Æsop's fable of the wolf and the lamb, and proved by no one more fully than by Prof. Thomson as soon as his writings are critically examined. . . . Incidentally, the famous

fable reveals the fact that mentalities of cross-feeding and in-feeding (predatory) species are vastly different from one another, and are almost antithetic, this justifying my remark that we are certain to interpret Nature differently, according to our varying feeding habits. The wolf interprets Nature so as to justify his physiological imperfections (his lack of cellulose-digesting apparatus, as Prof. Thomson would say), as though such imperfections were in no way the result of wrongful adaptation. Who can say that all adaptations are equally sanctioned, that all habits are equally valuable in evolution? Who can say what our limitations are in the matter of digestion, seeing that we have it in our power by adequate association with helpers (symbionts) to solve a multiplicity of otherwise stupendous biochemical problems, as I have often shown?

Prof. Thomson and his friends would have us believe that Nature is 'non-moral' and that species can get on quite as well without morality as with it, which is contrary to the facts, as it is contrary to human experience (constituting at least three-quarters of biology). This talk about 'non-morality' is in reality a counsel of despair, for the whole issue has merely been shirked as uncongenial study—hence the denials and clever-sounding criticisms.

Prof. Thomson, I am afraid, must be indicted as being guilty of writing biology so as to justify *homo rapiens* (to borrow a term introduced by my friend, Mr. Henry Salt), and this at a time of day when numbers of *homo sapiens* have found to their delight that they can exist quite well, and even better than before, by surrendering their erstwhile carnivorism.

With regard to "linkages" and inter-dependence of life, it is quite true that Darwin most meritoriously insisted on their importance. None the less, these factors are only imperfectly included in his theory, of which it may be said that it is 'paved' with inter-dependence much in the same way as Hell is 'paved with good intentions.'

With regard, more particularly, to Symbiosis, it is

constituted by systematic co-operation between species, chiefly animal and plant, and it is ultimately connected with nutrition, as also with sociality and ethics. Here, too, I have to demur that in view of the fact that these important connected matters have been neglected by the schools, it is scarcely becoming for Prof. Thomson to pronounce a kind of summary dismissal of my well-founded views on the subject.

The supposed merit of Natural Selection is that it is non-committal. It means merely the survival of the survivors, irrespective of sociology, of psychology, and of physiology. Let us have none of this non-committal biology. It is the science of the shirkers, of those loth to look facts in the face. Let us turn instead to a biology which is definitely committal, informing us about the good and the bad ways of life, enabling us to shape our course accordingly—*viz.*, qualitative biology, taking account of values, of good and evil.

I am a Darwinian, Sir, if you will, or if the distinguished scholar from Aberdeen still insists, in the sense in which the Archbishop of Canterbury is a modified Cadwallon. I have not taken up the cudgels in order to range myself by the side of this or that specialist, as Prof. Thomson would range me, meritorious though their work may be. My practical aim is the lifting of my generation out of the slough of scavengerdom in eating habits, due to a lazy compliance with low conditions—conditions that are answerable for disease and degeneration."

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"Evolution Reinterpreted."

(By H. REINHEIMER)

(Review by Sir Frank Beaman.)

MR. REINHEIMER may fairly claim to be the discoverer, as for several decades now he has been the valiant and unwearied champion, of the great principle of Symbiosis. Since the "symbiotic" reading of the universal evolutionary process violently conflicts with orthodox Darwinian biology, it is not surprising that his opening assaults contained in his ampler works, "Symbiosis," "Symbiogenesis," and "Evolution at the Crossways" met with a rude and discouraging reception in most of the recognised scientific circles. But he has continued, in numerous pamphlets and articles, to fight the good fight, and now, at long last, he begins to make his impressions, and sees his ideas, although too often without generous recognition, reflected in, infiltrating, and colouring large volumes of thought. The symbiotic has this great initial advantage over the Darwinian interpretation, that it denies once and for all the devastating Darwinian implication of nature's ruthless, ineradicable immorality. In place of all the old blighting Darwinian labels and shibboleths, "Nature red in tooth and claw," natural selection," "the struggle for existence" it substitutes a law in complete accord with the underlying ethic of all great religions, the law, namely, of generous and helpful co-operation. Instead of the Darwinian code of temporarily successful robbery and murder, the highest social virtue, willing mutual service, comes into play, and the author goes very far towards proving that this rule of good behaviour runs, and has always run, through every stage of organic life, from the lowest to the highest, making for all round efficiency and permanence.

One of the many defects of orthodox Darwinism was its failure to account for the extinction of species. In the light of fuller experience and saner thought it is hardly too much to say to-day that almost the whole of neo-Darwinian biology is concerned with the pathological phenomena of organic life without, apparently, any awareness of the possibility that there may be opposed to this set of phenomena yet another displaying biosocial normality and healthy growth. If it can be proved, as Mr. Reinheimer declares that it can, that co-operation and mutual service are indispensable conditions of all genuine evolution, orthodox science must perforce admit that it stands in need of radical reform. Such a new interpretation should at least be welcome to our modernist divines, who of late years have been so busy coquetting with science and trying to reconcile Darwinian biology and Christian ethics. That, of course, is quite impossible. Mr. Reinheimer's new principle of interpretation removes all difficulties and demonstrates a complete logical reconciliation.

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SYMBIOSIS

By H. REINHEIMER

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Evolution Re-Interpreted

BY

H. REINHEIMER

Author of "Symbiosis," "Symbiogenesis," "Evolution at the Crossways," etc., etc.

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Preface.

The present volume is intended as a re-vindication of the theory of "Evolution by Symbiosis" with its related nutritional theses, framed some 14 years ago by me as a substitute for the Darwinian theory of "Natural Selection," or what is called "The Survival of the Fittest."

The present attempt at substantiation of my position is provoked more particularly by the criticism of my book "Evolution at the Crossways," published in 1924, in "Nature"—a stronghold of Darwinism, where one usually meets with disfavour when one attempts to confine "Natural Selection" to the place to which it nevertheless, in my considered opinion, belongs, namely, the lumber room.

Vindication is also called for in view of the imperviousness of biologists to the truths entailed in new presentations of facts. It is as though the cult of Darwinism had rendered them purblind to any really tangible factor, however powerfully at work in life and in evolution.

Despite the opposition my theory has met with, I may say that, in a general way, the principles which I have, as a pioneer, defended so long, have gained ground, whilst those I have combatted have lost favour. "Evolution by Symbiosis," therefore, may face the future with some degree of confidence.

When I first published my views on nutrition in book-form, in 1909, it was possible for unscrupulous critics to disparage them by appeal to popular prejudice.

The same method is still being pursued. But it is less easy to-day to mislead the people by these means; for they are too much alive to the importance of food as a factor in health and evolution to be prejudiced, and they prefer the gold of health knowledge to the brass of catch-phrases such as "Natural Selection," which help no one except reactionaries. It is a hopeful sign of the times that people, rather than rely upon being "naturally selected" any longer, will endow chairs of dietetics, with a view to enforcing study and research which, however unpalatable the subject has hitherto been to biologists, are yet calculated to change the face of biological science, as long anticipated in my writings.

Some critics have been ungracious enough to hint that in my opposition to Natural Selection I am animated by personal bias against Darwin; this is far from being the case. I have no axe to grind, and I gladly acknowledge Darwin's great and outstanding merit as a pioneer of biology. My difference with Darwinism is due to the fact that, in my considered opinion, it is incompatible, not only with religion and philosophy, but also with science itself, and that it constitutes, in fact, the chief obstacle to the recognition of precisely those truths upon which, in my opinion, the progress of biological and medical science depends. I submit that many biologists, if they had had their vision opened, as mine has been, to the cumulative effects of nutrition in matters of health, of "fitness," and of success in evolution, would not have misinterpreted, as they have done, my remarks concerning the complete inadequacy of Natural Selection.

Nominally, Darwin's theory had to do with "fitness"; but the true cause of fitness it slurred over. What is equally objectionable is this, that with its one-sided emphasis of "struggle," of competition, and its assertion of the "injustice" and "immorality" of Nature, Darwinism tended to sanction a thoughtless and callous view of life, to uphold the love of promiscuous feeding, and, in a general way, to encourage the baser instincts

of man. How does refinement in feeding, for instance, square with the Darwinian idea of "digestive transformation"—the notion, still very widely entertained, that a successful modification of species, a real exaltation of type, is brought about in Nature by the habitual devouring of the weak by the strong—whereas it is, on the contrary, true, as I have often shown, that every form of carnivorism and one-sided exploitation of organism by organism is certain, in the end, to be harmful to health and evolution?

To such a pass have we been brought by Darwinism, that even our priests and prelates, apparently with more certainty than about their own Christian evangel, propagate the pernicious doctrine, taken over from Darwinism, of an "universal law," which, they say, "all of us must accept," consisting in "the conjugation of the verb 'to eat,' in the active and the passive." That is to say, at a moment when even the man in the street begins to realise that he can benefit in body, mind and soul, by using greater discrimination than hitherto with regard to food, leading ecclesiastics, more Darwinian than Darwin himself, come out openly, advancing the callous and wanton doctrine that organisms are under some kind of heavenly compulsion to devour one another—a great fallacy, which certainly will not help to approximate Christianity to biology, nor to increase one's respect for theological learning. Contemporary philosophy, we are told by those who ought to know, is returning to the thought of Pythagoras—a great pioneer also of food-reform, be it remembered. Yet our representative men are not yet Pythagorean enough to dare to be wise in a matter in which habit and convention play so large a part. They prefer to be modern and "Darwinian" in the practice of life instead, little realising that Darwinism is but a half-truth at best, based upon facile generalisations, upon premises and beliefs, not one of which can stand serious criticism, and therefore quite unreliable as a guide to conduct. It would seem to indicate a strange perver-

sion of thought when we find that not even our leading theologians can see that it is in large measure due to the facile acceptance of Darwinian half-truths that there is to-day a widespread prevalence of a kind of semi-paganism which they otherwise deplore. The combatting of Darwinism, it seems to me, is to-day the duty of every honest man, intent upon maintaining the very pillars upon which civilisation rests.

To me it has always been a favourite idea that the highest science and the truest theology are mutually consistent, and I have never wearied in my endeavour to demonstrate that the harmony between the two could be soundly established by fitting into one co-ordinated scheme, science, sociology, and ethics—a project certainly worthy of some consideration. All rightminded men and women should have sympathy with a new synthesis, capable of reconciling so much that has hitherto seemed irreconcilable and even bitterly antagonistic, whilst calculated at the same time to advance the true interests of science, religion, and healthy living.

My theory, in so far as it bears on the conduct of life, demands but little self-denial, yet in this, sad to relate, I am up against the prepossessions of both religionists and anti-religionists. It should, however, be remembered that we cannot as a rule have high results without a little sacrifice; and certainly the results that I am able to offer are worth all the sacrifice demanded.

It is time my contemporaries seriously bethought themselves whether by a slight change of physiological habits they might not gain, not only a new health, but also some new insight, some new orientation, even in science.

Those who insist on the dependence of mental upon physiological processes more particularly should be ready to admit that a new physiological dispensation might easily provide the groundwork for a new and better mental orientation. I hold that if we were more consistent in our obedience to the laws of physical

morality, we should also find it easier to be more consistent in our moral and religious life. And, conversely, if we were more consistent theologians, we should be better biologists, better physicians, and better sanitationists. We accuse Nature of inconsistency, but do not realise that there is only the semblance of it, due to our own inconsistency, which we have projected upon Nature.

We are particularly fond of libelling Nature by calling her callous and cruel—a way we have of justifying our own carnivorous proclivities. If Nature allows murderous species to exist, so runs the silent or overt argument, why should not we too live by murder—*a non sequitur*—as will be shown in the present volume.

Nature sanctions murder, so the pundits of biology claim. But supposing it should turn out, on a new reading of evolution, that Nature in reality does not sanction murder, that murderous species are penalised through becoming inevitably involved in pathological processes, the course and significance of which we have as yet failed to grasp?

Should this, if true, not cause us to desist from carnivorous habits? Logically it should, were it not that, as I have often stated, orthodox science defends the illogic of the palate against the logic of the facts of Nature. We have here come across, in my opinion, a crucial test of modern science. Is science what she claims to be, an austere devotee to Truth, erect and serene, as she is in appearance the successor of the men of old who brought down the light of heaven to men, or is this only very partially so and is she largely composed of pretence?

In the matter of Food, we have an opportunity of making an important practical application of evolutionary teaching; but our biologists, instead of fastening on it with alacrity, shirk the matter with subterfuge and casuistry. When lately they were so remarkably unanimous in condemning the Fundamentalists, may

they not have been unmindful of the beam in their own eye ? One of them, whilst lecturing these staunch farmers of Tennessee, pointed out that it is impossible to pick and choose those parts of science that appear likely to suit one's digestion.

But that is precisely what orthodox biologists have done hitherto. They have stressed only those parts of biology of which, in their own words, it was possible to make "good science," *i.e.*, such parts as lend themselves to one particular kind of experimentation without need of taking into consideration food, sociality, morality, and the like, for which all-essential matters these superior men have no taste.

What is it that constitutes normal feeding, normal metabolism, was not given the least consideration. What is " respectable " and ordinary was defended.

Biologists of the same school as those who condemned the fundamentalists, would make out that orthodox biology and religion are quite compatible. This, however, is contrary to the facts, as is well known.

Numerous writers have testified that biology has hitherto exercised a blighting effect upon religious ardour, and that its whole drift has been adverse to religion. It has libelled nature as "red in tooth and claw," as a " dismal cockpit," and, although, under the influence of disillusionment with regard to most of their theories, biologists no longer indulge in violent diatribes against, and abstain from virulent criticism of, religion, yet they still adhere to the more objectionable parts of Darwinian materialism.

Emphatically it must be stated that conventional Darwinism cannot be said to constitute any support whatsoever of religion, although a sane biology would. The aforementioned biologist protests too much, and, no doubt, would fain sit on two stools at the same time. Were it not that he otherwise expressly upholds carnivorous methods as constituting a norm of nature, we might give him credit for a change of heart.

The fact remains that through the dictums of Darwin, Huxley, and their followers, science has proclaimed that what may be called religious values in no way apply to nature, that on the contrary, in nature criminality prospers equally well with honesty. A little felony, according to Darwin, does no harm, so long as the felon just stops short of altogether defeating his object. The spirit of religion is that of righteousness ; the spirit of Darwinism that of iniquity, constituting it, in Tennyson's words, " Procuress of the Lords of Hell."

Modern man wants to be entirely unshackled, and what appeals to him greatly is getting rich quick by any means. Hence the popularity of Darwinism, which is relished because of its refutation of religion and its condonation of the grab spirit. Darwinism constitutes the religion of the week-days ; Christianity is good enough for Sundays. It is becoming clear, however, to some minds that through loss of spirituality we are in reality on the road to anarchy, and therefore it is that some thinkers plead for a wider view on life and on evolution. That wider view of evolution, for which I have contended now for several decades, involves a more idealistic outlook with regard to the " natural process " than does Darwinism. But for the shallowness of European culture it might ere now have been profitably assimilated into the general thought of our time, and much evil and much conflict would have been avoided. It might have gone a long way in allaying the renewed feud between science and religion. It might have reduced to a considerable extent the contrast between east and west so that the twain could meet more fruitfully than has hitherto been the case, this constituting another practical issue of some special importance to this country.

There is to-day a veritable spiritual revolt of Asia against the trend of European culture, as was pointed out the other day by Ikbal Ali Shah in the " New Statesman." It is the materialism of our Western culture, according to him, that is the root of the mischief,

causing so totally different an outlook on life from that customary among Asiatics. Although Western scientific civilisation has had some triumphs in India, yet this writer testifies that it does not make better men of Asiatics. It does not render them, as he says, "assets either to our educators or to the world at large." The graft of the West, he states, simply cannot become successful "in the manner in which we are receiving it." Asia, therefore, is in revolt, and we are further told: "The very ideas of civilisation are challenged, and a definite question is asked as to what are the aims of the present system of civilisation; for it is contended that if it means progress in locomotion, wireless telegraphy, electrical devices, it all distinctly points to a deification of human material comfort, which bears in its train the germs of unspeakable vice and misery, and even perhaps of the destruction of the higher aspects of philosophy and religion. It is further argued that this system of civilisation presents a danger to the West—our instructors—in as much as it threatens to strike at the very root of Christianity. In the words of Lord Ernle, 'in 1850 it was a courageous act to question details of orthodox Christianity; to-day in certain circles, courage is needed for their defence.' All these factors are held up before the Oriental mind to-day, and it must be stated that in consequence there is a distinct flow backwards, back to the real essence and spiritual force of Old Asia as opposed to the glamour of Western civilisatian. In certain cases and respects a clear challenge has already been thrown to the materialistic and scientific movement of Europe."

That modern science has hitherto made us not more but less spiritual, and that this means a serious loss, is now dawning upon many minds in the West. Nor is spirituality without its practical "business" side. Quite as "practical" an issue as the contrast between East and West is the state of our business morality. No small section of the American business world openly sympathised with the Fundamentalists of Tennessee, for

the reason that they instinctively realised the fact that if traditional religious beliefs are questioned and flouted, there can be no security for the economic assumptions of existing society. Nor were other sympathisers of Fundamentalism in America merely bigots, as an orgy of misrepresentation in Europe made them appear. Many were merely desirous of maintaining the historic Christian faith without denying that it too must change in a changing environment. In a spirit that betrayed neither arrogance nor obscurantism they denied that a mere hypothesis, a thing of yesterday, such as Darwinism, was fit to supplant the world's sublimest teachings. In this, I aver, the Fundamentalists showed a far greater sense of the fitness of things than their biassed accusers. "We refuse," said one of them, "to abandon to the student of natural science the entire realm of facts in order to reserve to religion merely a realm of ideals." Further enquiry is what is pleaded for, rather than the granting of the last word to Darwinism.

Rather than a literal interpretation of the Scriptures it is their spirit that counts, and decidedly I declare that in refusing to give up their religion for the sake of Darwinism, the Fundamentalists made a better choice than those who gave up religion for the sake of Darwinism, as did, for instance, the late Professor George Romanes, upon whom at one time it was thought the mantle of Darwin had fallen. He, typical of most "scientific" Europeans, completely gave up his belief in God, because it seemed to him that the conclusions he had reached as the result of his study of Darwinism demanded this surrender—so greatly are men impressed with their own "research," their own idle guess. Romanes wrote: "I am not ashamed to confess that with this virtual negation of God the universe has to me lost its sense of loveliness. When I think of the appalling contrast between the hallowed glory of that creed which once was mine, and the lonely mystery of existence as now I find it, at such times I shall ever feel

it impossible to avoid the sharpest pangs of which my nature is susceptible."

These lines do honour to Romanes more than his "research." Evidently religion to him was more than a mere veneer, and one wonders how he could ever have given up religion for the shibboleth of "Natural Selection," which is a fallacy from every point of view, and which should never have been employed otherwise than a "working hypothesis" for biologists confined to a limited field. Fortunately it can now be fully shown that Darwinism was based on a series of uncritical assumptions, and that Darwin's interpretation of Nature must give place to a truer and nobler one, which we foresee must be forthcoming—one more in harmony with scriptural tenets and carrying the promise to make faith and science one, as they should be.

The conclusion now clearly issues that experiments made under domestication are not conclusive. Darwin supported, chiefly by the example of variation under domestication (selection), the evidence already existing that organisms have often changed during long periods of time. It remained still to be seen, however, whether variation under domestication was really typical of evolution. This, with the further perspective now attained, is known *not* to be the case.

Change *per se* is not sufficiently illustrative of the evolutionary process, for besides change another factor of greater importance is involved, viz., synthesis. The modification of species often proceeds at the cost of future ruin, as in degeneration, which consists of a breaking down or a decline of function or of parts. This often takes place in domestication, as Darwin himself has demonstrated. Hence, contrary to his opinion, domestication is not a safe clue to evolution.

In trying to establish an analogy between "selection" (in domestication), and the method of the natural process, Darwin makes use of "as ifs" as if they were "therefores"; for there is only an "as if" analogy given by Darwin. An "as if" accepted as an

" is " becomes a presupposition, from which follows the " must be " so obviously and so fatally that it is accepted. The acceptor of the " as if " is certain to go astray before he has travelled very far.

Huxley always thought that it was a weak point in Darwin's theory that he could not show selective breeding to be a *vera causa* for physiological, *i.e.*, true natural species; and modern geneticists tell us that nothing that has happened since at all mitigates the seriousness of this criticism. Physiological species *cannot* be produced by selection; and this conclusion once accepted shatters the Darwinian hypothesis; and candour has obliged biologists to admit it.

Therefore, with confidence we can say, that the attempt to elucidate the origin of species along Darwinian lines has utterly broken down. On the other hand, as I have shown, the norm of evolution, free from the blemishes of domestication, is provided by Symbiosis, viz., systematic co-operation, seen to be active in nature between different species, particularly between species belonging to different kingdoms. Herein lies the explanation of progressive evolution through mutuality, by symbiotic integration, *i.e.*, by the summation of powers in co-operation.

There will come a day, according to Claude Bernard, when physiologists, poets, and philosophers will speak the same language and understand one another. This happy consummation—the establishment of a universal science—will be hastened if it is but realised that " evolution " is not a special preserve of the zoologist, but that it is essentially a subject requiring contribution from every department of human thought. There is no doubt whatever that in the past political ideas have too greatly influenced science. Darwinism, with its one-sided emphasis on warfare, mirrored the political bias of the half-informed pagan mind, of Napoleonic and Bismarckian Europe.

Happily, political theories are now on the mend, and, one may presume, this will not be without

repercussions upon natural philosophy, which will accommodate itself to the newer spirit of the age.

In political life the recognition is gaining ground that it is a fallacious theory which declares that one nation can prosper only at the expense of another nation. Much sounder, and in closer accord with the spirit of modern progress, is the belief that prosperous nations make the best customers, and that prosperity of nations depends largely upon useful reciprocal relations. This has its parallel in biology in the recognition that Symbiosis, *i.e.*, systematic co-operation between organisms of different species, is of fundamental importance, that, indeed, species as well as individual organisms co-operate just as classes and nations co-operate in international trade, or as individuals in a town or factory and always with immense mutual advantage.

Similar recognitions now emerge in social theory. "All true government," says *The Times*, 23/6/25, "must rest on spiritual sanctions. Law, commerce, wealth, military power cannot secure any nation's true well-being. We are slowly learning that, just as man cannot live by bread alone, so neither can any nation live by its material resources alone. There are many ways of more vital importance to a people than national success. Co-operation ultimately depends on spiritual affinities, and any empire which neglects them is most surely on the road to decay. Different races do not maintain harmony amongst themselves merely under the impulse of a common policy secured by their hope of gain. True union in a nation, or fellowship between various peoples, depends on the recognition of those eternal verities of righteousness, brotherhood and mutual service in obedience to which men attain freedom to be their best, and count nothing higher than to share their liberty with others."

Such and similar recognitions will prove valuable stepping stones to the new biology for which I am pleading.

Introductory.

If Darwin, instead of trusting with great infelicity to merely expedient adaptation as the *summum bonum* of life, had, in enunciating his theory of "The Survival of the Fittest," provided a standard of fitness or of efficiency, his theory might have proved more satisfactory than it has done. It might, *inter alia*, have shed some considerable light on the problem of disease, as the converse of "fitness," to the benefit of suffering humanity.

An evolutionary theory which makes "fitness" the corner-stone of the whole argument should be one capable of enlightening us also with regard to "unfitness," and, if it fail therein, should be held to have come to grief over a crucial test, and to have miscarried.

I submit that Darwinism has ignominiously failed to inspire medicine, which is still devoid of a valid theory of disease, whilst our physicians are as baffled as ever by cancer and similar problems. Quite recently, a medical man has published a book on "The Meaning of Disease," in which it is maintained that there is no adequate theory of disease at the present day; and a distinguished physician, who was asked what he considered the most important medical discovery of the present century, replied: "The discovery of our own ignorance."

Darwinism, so far from helping us, has, indeed, on the contrary, tended to confuse the issue. It has acted as a shield of ignorance, as Samuel Butler rightly stated long ago.

Sir Arthur Keith, the distinguished anthropologist, recently assured us that Darwinism is immaculate. Such statements are necessary from time to time to restore faith in this, the most fanatic cult of modern times. Sir Arthur (whose fondness for using the big stick is notorious) says in "Nature": "It is difficult to believe that anyone who sees the unceasing struggle which goes on everywhere and every year for the possession of the continents of the world, and has been waged since the dawn of history, a struggle which is attended by the spread and domination of a few favoured races and the retrocession and obliteration of many less favoured races, can doubt the potency of Darwin's law of selection as a factor in the process of evolution."

This is an exaggeration. I can assure Sir Arthur moreover that it is possible without losing sight of historical occurrences, which are but one side of the picture, to put quite a different complexion on the matter of the method of evolution. One may hold, for instance, as I do, without any need to resort to the fictitious "selective" jargon, that supremacy in the end rests upon true fitness—upon that fitness of which Darwinism has not even an inkling, the fitness which is the true antidote to disease, and in the understanding of which Darwinism has signally miscarried. Sir Arthur is evidently convinced that it is better to get on with "favour" than without. I, too, have seen it, ere now, though sometimes with misgivings. I, too, might have achieved some favour by styling myself a Darwinian, or by defending that creed. I might have found it more "Darwinian," *i.e.*, more expedient to do so, had I not held fast to some old-fashioned virtues, which Darwinism tends to discard. When it comes to "seeing" the truth of a thing, as Sir Arthur bids us do regarding Darwinism, a Mahommetan probably "sees" just as clearly that Allah is God and Mahommet his prophet as our Darwinian "sees" that Darwin is infallibily correct.

Applied to, say, the incidence of cancer, the Darwinian view amounts to this: the "favoured" people escape that fell disease, and the "less favoured" succumb to it. But, manifestly, such sophistry does not help us to apprehend the cause of cancer, and, similarly, Darwinism is at arm's length from reality with any other practical issue that we may take. Even to regard cancer subjects as in course of being "naturally selected," or "eliminated," whilst the more "favoured" have been "preserved," does not assist us in the least. Such formulation is sheer verbalism, mere "sound and fury, signifying nothing." "Preservation" and "non-preservation" (in a metaphorical "struggle for existence") have jointly produced evolution—that is the quintessence of Darwinism, which never gets beyond truisms, or deals with the real significance of things, even with that of its own chief bugbear, the "struggle." The Darwinian cult has no standard of fitness, nor, for that matter, of any values whatsoever. Even if we grant, as we are willing to do, that behind the sophistry there lurks a vague notion of the necessity of making efforts on the part of the organism, we are yet left entirely in the dark as to the kind of effort most needed to achieve the "favour" of Nature.

When Herbert Spencer coined the expression "survival of the fittest," as an alternative to Darwin's "natural selection," he did not explain that in reality the formula amounts only to this—the survival of the most "favoured," *i.e.*, of those regarding which it is not known why they survived. "Survival by favour" leaves the door conveniently open to all manner of conjecture, according to the predilections of the interpreter. It all amounts to this: Survival by the "X" factor. In a sophisticated sense, therefore, it may be said that the theory is correct, since it leaves the factors indeterminate, and does not commit itself to any one of them. Any or all may be right. The place of "X" may, in the future, be taken by luck, or cunning, or by food, climate, soil, co-operation, competition,

warfare, etc., etc., and still Darwin is, algebraically, correct. Only we get no real help from him.

The modern spirit cannot be content with anything less than an interpretation in terms of physiology, sociology and psychology of the method of evolution. But ask a Darwinian whether "Natural Selection" comes under any of these headings, and he will be perplexed. He has, indeed, never troubled himself about these factors, having ready a convenient entity to which to refer causation of evolution. He might tell you that all these and similar factors are implicitly contained in the formula. But he is far from being able to detail them explicitly, so as to be of practical use, and it is thus clear that his excuse is very lame. What the theory has in reality done is this, it has relegated the most important factors to the background, thereby impeding the advance of science generally. It has saved mechanism in biology by sacrificing everything else to it. To astute critics it has been clear for some time that "Natural Selection" is but a synonym for "Nature"—with special emphasis of the "red in tooth and claw." This emphasis has been so monstrously overdone as to make it appear feasible that Nature has no concern whatsoever with morality. The morality of Nature was in fact depicted as so low, so near zero, as to make it practically identical with "non-morality"—a convenient way of shelving altogether a quantity that is neither amenable to laboratory research nor presents congenial study for a naturalist. With morality conveniently out of the way, on the Darwinian system, a murderer, a thief, or a parasite, so long as he "adapts" and "survives," is the peer of the honest organism which lives by work and Symbiosis (mutual service in life partnership). That is to say, the abnormal is taken for the normal, and there is scarcely room left in the Darwinian theory for considerations of abnormality, or for the concept of depravity, either as connected with physiology or with morals.

Indeed, these delinquencies are not supposed to exist as such, or, where they are nevertheless conspicuous, are not supposed to be *contra naturam*. Darwinism has tended, as more than one thinker has emphasised, to emasculate the moral ideal in the modern world. It is evident that we can get little practical help from a system such as this, which has no standard of values, which has even deprived biological science of the very means of sifting the grain from the chaff. The effect upon cognate departments of science could but have been what we find it to be. Pathology, for instance, which in reality commences precisely where the seamy side of biology begins, and should, hence, form a prominent chapter in the evolution theory, has been treated as a mere side-issue, and is confined to the study of a few exotic malformations; whilst, on the positive side, consistently enough, the effect of Darwinism has been to draw away the attention of science from the most important synthetic factor of evolution, namely, Symbiosis, which has similarly been relegated to a back seat. The evolution of disease, and the creation of health, both appear as haphazard in Darwinism as the fall of a meteor in the night sky. It is no wonder that from such a quarter medicine could derive no inspiration. Darwinism has focussed the attention, not on really important, but on recondite matters, on imponderables, such as "variations," which have no existence in themselves, but are part of a greater physiological whole, the fate of which depends precisely on factors which Darwinism has neglected to study. Darwinism is, to me, a synonym for false values. No severer indictment could be framed of any other "ism" or cult. There can be no doubt that biology is sadly in need of a new synthesis. Dissatisfaction is rife with its present inchoate condition. As one writer declared in "Nature," 3/11/23, "Biology is in an unhealthy state," and another, *ibid.*, 23/2/24, "The present state of biological philosophy is unsatisfactory."

In my opinion, the blame for this is to be laid

chiefly at the door of Darwinism. Evidently a great change has to come over the "scientific" scene, before we can hope for improvement from that quarter. Is science going to change? The "Times" suggested the other day, in a leader, that modern science, whilst being in some respects practical and *pro tanto* dull, had at last put itself into its own place (without having been put there, disputably, by others); and that place (in the writer's opinion) is not quite what some of its more enthusiastic, if less cautious, followers thought it to be in 1860. "There is room for things besides science," the leader writer goes on to say, "above all for value; for now that nearly everything is known and nothing new will astonish, the worth of things worthy is free to assert itself, and the worthlessness of things unworthy."

Such change, however, has not yet reached the representatives of the biological sciences, who still assume omniscience in the most approved 1860 style and are unwilling to divest themselves of the halo of the medicine man which also is part of their inheritance. Not content with being quite unrepentant about "Natural Selection," Sir Arthur Keith proceeds to place under the ban all those who venture to differ from him. He says that his few sentences (his *ipse dixit*) must suffice to show that Darwinism, in whatever sense we construe it, is neither an exploded creed nor a dead doctrine, and, more pontifically still, that "those who assert the contrary not only sin against the light of truth, but also commit a crime by poisoning the springs from which a trusting public (sic) drinks its information."

This is the veritable spirit of the Inquisition reincarnated. One wonders how it is possible that so distinguished a scientist as Sir Arthur should find it necessary thus to indulge in bluff and in obscurantism. Posterity may know some day what game it is that is being played in this upholding Darwinism at any price. There are, moreover, a number of distinguished biologists who show divergence from Sir Arthur's dis-

pensation. Are they all alike to be excommunicated, or to be burnt at the stake for poisoning public opinion? There is Dr. W. J. Sollas, Prof. of Geology, for instance, declaring the following: "It is no secret that Darwin's explanation no longer occupies undisputed possession of the field, and there are without doubt many distinguished investigators who freely admit that a satisfactory explanation (of the method of evolution) has yet to be found. For myself, I confess that I regard the Darwinian explanation as only a half truth." *Nature*, 11/7/25.

So Dr. Bather, of the British Museum, thinks that it would do us all good to drop "that blessed word evolution" for fifty years. Dr. D. H. Scott, the botanist, states that there have been several frank statements by eminent biologists, who have acknowledged how little we know of the methods of evolution. Prof. E. W. MacBride (who is not unacquainted with Sir Arthur's big stick), is inclined to give but a minimum of credit to the operation of Natural Selection, believing as he does, in the inheritance of the effects of the environment. It seems to him that Tornier's observations, in particular, "have dealt a deadly blow at the whole 'mutation' hypothesis of evolution, as well as at that part of Darwin's argument which is based on the comparison of the abnormality shown by our domestic breeds, and the differences which distinguish natural species of animals."

Prof. M'Dougall, the psychologist, likewise rejects Darwinism, or, more specially, Neo-Darwinism ("Darwinism minus Lamarckism") which, as he says, leaves no scope for the operation of intelligent purpose. "It is now duly recognised," he says, "that the strict Neo-Darwinian theory of organic evolution is inadequate . . . it finds itself at the conclusion of its attempt with mind upon its hands as an enormous remainder of surd which cannot be ignored, save at the cost of absurdity of the whole scheme."

Again, a critic of the scientific naturalism of "the well-established firm of Democritus, Holbach, and

Huxley, Ltd.," writes as follows in the "Hibbert Journal," Jan. 27: "If all things in heaven and earth could really be thought of as capable of being fully and finally revealed to man by the scientific method; if physics was not only the most fundamental science but also the most fundamental of philosophies; if, indeed, there should exist no metaphysic but science, then of course the world would be safe for mechanistic biology, and a place fit for biochemists to live in. Unfortunately, this is an impossible dream. Ruins are ruins, and to make the scientific method with its dependence on the inductive process, its constant employment of statistics, its suppression of the individual, its inevitable tendency to analyse, its rejection of all entities which cannot be numerically expressed, and, in a word, its formidable subjectivity, into what we might call God's Own Method, is now more than ever a hopeless task."

Prof. MacBride thinks that the only way effectively to combat the mechanistic view is to build up a thorough and convincing idealistic criticism of it. Yet another way, surely, is to re-interpret evolution entirely, so as to include those very factors which Darwinism has wrongly excluded. This is indeed the task to which I have devoted myself now for several decades, though knowing full well that it is a formidable enterprise from more than one point of view.

That orthodox Darwinians will not be pleased with any new theory of evolution whatsoever, never mind its advantages, will be clear from what has been said about their obscurantist attitude. A reviewer of my book on "Evolution at the Crossways," in "Nature," 4/10/24, signing himself G.P.B., treats with sarcasm the idea that twenty-five years of dietetic experiment should have enabled me (as he puts it), to frame new theories of evolution. He betrays that impertinent contempt of the nutritional factor which is so common amongst zoologists, who live idly on the prestige of that great amateur scientist, Darwin, and are too hide-bound to see that nutrition is fast becoming the masterword

in the whole biological field. Mediocrity is for ever meditating how to forge new chains for uniformity. "Picture the situation to-day," says a theological writer, "if a sudden conversion to Darwinism had moved the Church some thirty or forty years ago, to plunge into an evolutionary creed. Natural Selection would by now be a dogma, and every biologist who proposed to depart from it would be denounced as an infidel or a rogue."

Assuredly, if any one thing, more than another, is calculated to-day to qualify a writer to frame new theories of evolution, it is a thorough understanding of nutrition, whilst on the other hand, nothing more surely disqualifies a man than nescience concerning that vital subject. If a book is at all worth noticing in "Nature," one would presume that its author had provided some little evidence for the theories advanced therein. But where is there any notice or acknowledgement of the fact that such evidence has been produced? It is all slurred over, and treated as non-existing. Such reviews are written with a view to creating bias against the author and in order to nip his work in the bud. What is wrong with my views is not stated. Merely this, that they do not square with, but run counter to, those of Mr., or Prof., G.P.B. But to condemn them on that account is surely a *non sequitur*. The correctness or otherwise of my views depends upon the evidence that goes to support them. Were my critic a man of candour, he would have admitted that my theories involve departments to which he has not hitherto given any attention whatsoever, with which he is not competent to deal. My divergence from orthodoxy could not better be illustrated than by a summary of the counts on which the scribe in "Nature" condemns me (Nature condemning him). Here is the indictment. I am accused—

(*a*) Of having produced too pleasant a picture of the evolutionary process.

(*b*) Of having imputed morality to nature.

(*c*) Of considering parasites as abnormal and involved in pathological processes.

(*d*) Of believing that habitual predacity is harmful to the organism, and that predacity inevitably results in deformity, inferiority, disease, degeneration and death.

(*e*) Of ignoring the fact that dogs are cleverer than sheep.

(*f*) Of promulgating a wrong theory in declaring that Nature abhors perpetual in-feeding (like on like, as plant on plant, animal on animal).

(*g*) Of misleading the public into the belief that sooner or later predacity and beauty must part company.

(*h*) Of misreading the signs in positing a pathological element behind excessive reproduction.

Let me state, first of all, in answer to this formidable list of charges, that my various volumes are replete with evidence in support of my contentions—volumes which G.P.B. has, of course, never seen fit to consult. Let me say, too, that one of our foremost philosophers and mathematical physicists, Prof. A. N. Whitehead. whose work "Science and the Modern World," has created such a stir, has practically endorsed my co-operative view of evolution.

Thus, on p. 205 of that work we read: "The watchwords of the nineteenth century have been, struggle for existence, competition, class warfare, commercial antagonism between nations, military warfare. The struggle for existence has been construed into the gospel of hate. The full conclusion to be drawn from a philosophy of evolution is fortunately of a more balanced character. Successful organisms modify their environment. Those organisms are successful which modify their environment so as to assist each other. This law is exemplified in nature on a vast scale. (Here follow the usual examples). The lions and tigers are not the successful species. There is something in ready use of force which defeats its own object. Its main defect is that it bars co-operation."

(That the abuse, and eventual consequent loss, of co-operation, *i.e.*, the "divorce from Symbiosis" is the main cause of disease and of degeneration, is one of my chief contentions).

Now let me deal, point by point, with the above criticism of my view. Either there is such a thing as interdependence of life, or there is not. If there is, then the sooner we discover the laws which rule it the better. Darwin, realising the fundamental importance of the subject, implored us to study "mutual relations," as the most probable source of enlightenment on evolution. Here is, indeed, the whole crux of the difficulty with regard to evolution, if only orthodox biology had had the talent to tackle the economics involved. My chief crime in the eyes of orthodox biologists is that I have performed that task for them, and that this has led to a picture of the world different from that which they entertained. I have shown, *inter alia*, that co-operation is more fundamental, and also more important, than competition, and that the value of competition is merely to keep co-operation efficiently in being. This is altogether too much for my orthodox traducers, for they did not wish to be bothered with economics at all, and had merely allowed competition to come in by a side-door, as a kind of *deus ex machinâ*, a kind of Siva, to perform everything that they could neither understand nor explain. It is easier far for a biologist to work with such a convenient deity than with economics and philosophy—disciplines for which he entertains the most profound disdain. Thus would Hottentots explain phenomena more easily with the aid of spirits than with the aid of science. Whether Darwinists like it or not, evidence of co-operation is steadily accumulating, this showing that I have exaggerated neither the importance nor the scope of the co-operative factor in evolution.

Firstly, with regard to the extent of co-operation. New knowledge is pouring in concerning the important matter of the symbiotic distribution of seeds by the agency of birds. Birds have not yet been given all the

credit that is their due as planters of trees, groves and hedges. Yet miles of hedges are constantly springing up from the seeds they drop when perching on some bare fence after feasting on hips and haws.. Dr. W. P. Pycraft, an excellent naturalist, whom few would accuse of attempting to paint fictitious pictures of the world, writes under date, 25/10/24, that the part played by birds in the dispersal of hedgerow fruits is by no means generally realised. "We are supposed, by some, to know all that is to be known about our native birds. Yet, even in this matter of fruit dispersal we know very little indeed. There were many who believed that only by the merest accident could seed survive after passing through the intestines of birds. The botanist Kerner was the first to put this matter to the test of experiment. He used the seeds of no fewer than 250 species, carefully watching their fate after being swallowed by birds. In these observations he made use of thrushes and robins, various members of the finch tribe, ravens and jackdaws, turkeys, pigeons and ducks. The blackbird ate everything, "even the arils of the yew," rejecting the stones from the crop, as hawks eject the feathers and bones of their victims. No less than seventy-five per cent. of these various seeds, swallowed by the blackbird, eighty-five per cent. in the case of the thrush, and eighty per cent. in the case of the robin germinated, though more slowly than seeds which had not passed through this ordeal. The seeds of berberis and of currants, on the other hand, germinated more quickly after having been ingested."

When we speak of "the kindly fruits of the earth," we are thinking most generally of the dessert table. But among the hedgerow fruits, as Dr. Pycraft reminds us, there are many that we do not covet at all. Some we should find tasteless, whilst others we dare not touch. "Let us leave them to the birds, says Dr. Pycraft," adding significantly, "whose birthright they are."

Is this not a kind of acknowledgment of rights and duties in biological reciprocity, in bio-morality, in fact ?

The birds, we are told by the same naturalist, "sow for the harvests yet to be." In as much as they do so, they seem to be clearly entitled to their rewards, and the law of co-operation is thus seen to over-ride that of brute force, whilst it is also evident that the picture of the natural process, as drawn by me, depending chiefly on mutual services of one kind or another, is not overdrawn. Even in outward appearance, I should say, the pleasantness of the co-operative picture is not overdone; for, as Dr. Pycraft continues, and as it is of course well-known to those who have given attention to the matter, "it is to secure these sowers of the seed that nature has used her most beguiling colours." In other words, out of the system of mutual service between plant and animal—Symbiosis on the grand scale of nature—*i.e.*, Norm-Symbiosis, there has arisen great pleasantness, beauty and sense of beauty. Beauty is for ever connected with the useful, and it is never unconnected with the moral element.

Even rooks and magpies will deliberately plant seeds, many of which grow into trees, since birds forget many of the hiding places. In an old book on natural history, a writer describes how he observed a flock of rooks, engaged in planting acorns, digging holes in some mossy ground with their bills, then dropping in the acorns and covering them with moss. Twenty-five years later there had grown up a grove of oaks (the landlord having protected the seedlings as curiosities) of a suitable height for the rooks to build their nests therein. We have here in fact systematic bird planters.

With so much wholesome activity going on around us, on every hand, can we believe, as Darwinians would bid us do, that nature is a shambles?

To such a degree are biologists dominated by the influence of Darwin and his "war-dog," Huxley, with their gospel of war and damnation, that they are morbidly afraid to take a generous view of Nature. At first they received the concept of Symbiosis with indignant scorn. Fortunately, it is no longer possible to repudiate it to-day, the facts being too soundly estab-

ished. But still there continues to be much prejudice. As a rule, Symbiosis is construed as but a casual phenomenon, on the borderland of disease and of parasitism, of which phenomena it is, in reality, as I have often shown, the very opposite. So it was averred that "symbiotic adaptation" culminated with the birds, and that the mammalia were indistinguished in Symbiosis, which, if it were true, would, indeed rob Symbiosis of much of its significance. It is overlooked, first of all, that man, the chief of the mammalia, is in very truth the conscious symbiotic partner of the plant. His premier industry is, and has been, for ages past agriculture, and what is this but the care and cultivation of the plants, his indispensable partners ?

Well is it known that the mammals as a class are very fond of grains, nuts and fruit, all of which have played a great part in mammalian evolution ; and the fact is now emerging that the mammals render many important and hitherto unsuspected counter-services to their vegetable benefactors. We see the squirrel burying hazel, beech, and oak seeds, as a store for the wintry season, forgetting the "cache," or storage place of some, and thus allowing them to germinate. Mice, rabbits, and pigs likewise aid in similar ways, and so do elephants, oxen, sheep and goats, bats, and even some of the carnivora (frugo-carnivora). To the tree such aid is a great boon, since it is easier for it to produce an abundance of seeds than to obtain reliable distribution. One cannot but marvel in this connection at the power of contrivance exhibited by the plant. Humble though it be, it is the great mediator between the earth, *i.e.*, the inorganic world, and the animal. Plants are the fundamental capitalists and the contrivers of organic civilisation, and have enlisted the services of the animals on principles of equity of compensation. Man is dependent for all he is, and for all he can ever hope to be, on the plant. In "The Silviculture of Indian Trees," Prof. R. S, Troup provides a number of interesting examples showing how animal agency, particularly mammalian, is often quite indis-

pensable to the distribution of trees. Amongst the examples given is *Cassia Fistula*, belonging to the great order of the Leguminosae, and one of the most handsome of Indian blooming trees. The tree is in general not gregarious, Indian trees not being conspicuous for this characteristic. Yet, strange to say, *Cassia* sometimes does exhibit gregariousness—in localities frequented by monkeys, which, being symbiotic partners, act as disseminators of seeds. That mammals thus impose gregariousness on useful trees, over and above the benefit they confer by distribution, is in itself a very noteworthy fact. Its bionomic significance is enormous. We seem to be more familiar with the reverse, though equally significant, phenomenon of vegetable-sustained animal gregariousness. Now gregariousness is a great essential to progress, both in vegetable and in animal life, and it is powerfully aided by Symbiosis, as was shown in my book on Symbiosis. When an organism is as dependent upon another as the animal is upon the plant, it would be futile to imagine that it could proceed upon an evolution of its own, irrespective of the claims of others. Those who have studied cases of interaction should find it easy to understand that nothing short of co-evolution could have been the norm of evolution, all isolated developments leading into blind alleys of evolution. It is now generally recognised that mammals are unable to synthesise vitamins, and are entirely dependent upon the supplies which they obtain either directly from plants or at secondhand from the flesh or milk of other animals. This renders them primarily dependent upon "Norm-Symbiosis," and one might have prophesied from that fact alone that Symbiosis cannot be absent amongst mammals. It is not denied, of course, that organisms have been largely unconscious of the fact of partnership, nor that they have frequently transgressed against equity and righteousness. What is to be affirmed, however, is that in practice, owing, no doubt, to constitutional laws of the universe, the principle of *do ut des* showed to greatest advantage. The problem

before life was to provide in the most economic way the needs of appropriate partners, actual and prospective. The plant's way of solving it was by increasing and improving food supplies, which, if it rendered losses inevitable, yet, in the end, resulted in a better chance of survival and of success. None should attempt to escape sacrifices altogether. The plants have certainly shown us how lower interests must be sacrificed for higher in the attainment of progress.

It may be asked what profits it the plant to have gregariousness imposed upon it? The causes of many deficiencies in British trees—open and irregular grain, superabundance of large knots, a relatively large amount of soft tissue, lack of durability, shortness of bole and excessive taper—have only recently been recognised. They may in the main be attributed to a single cause —namely, a too open condition of our woodlands, that is to say, an insufficiency of trees—in other words, to lack of gregariousness. Many trees do not "clean" themselves properly, except in densely stocked woods. Hence it is that animals, by compelling gregariousness, may improve the trees in some vital respects.

It is also evident that the true mammalian allies of the trees are not the bloodthirsty carnivora, which, in the absence of adequate feeding habits and of due co-adaptation to vegetable life, are practically debarred from intimate alliances with plants. Their true friends are the gregarious "cross-feeding" herbivora, and especially frugivora, which in their habits and life processes comply with the rules of Norm-Symbiosis, *i.e.*, they duly compensate their vegetable partners by symbiotic services, instead of relying for their sustenance on methods of theft and murder.

It is not difficult to understand in this connection that, in proportion as mutual service in Norm-Symbiosis increased, new scope was provided for a lengthening of the span of life, for longevity, and for an enhancement of status. The tree, in furnishing increasingly adequate spare products for symbiotic partners, incidentally and *pari ratione* elaborated better embryonic food material

for its own progeny. That is to say, it is the part of Symbiosis to conduce to an augmentation of reproductive expenditure. This likewise involves protracted gestation and prolonged "parental care," both of which conduces to longevity and, likewise, to exaltation of type. This power of Symbiosis thus to give direction to the evolutionary process itself I have termed "Symbiogenesis." Let us trace the operation of this principle a little further. In the course of evolution, such vegetable gains as above described communicated themselves to the co-evolving animal, in so far as it sustained itself on the spare material of the plant, which material acts as specially elaborated food both to symbiotic partner and to vegetable offspring, controlling and directing their evolution. The case is exemplified by the evolution of the mammalia, which had to wait for the emergence of the plants—the Angiosperms—which had learnt to afford prolonged protection to their seeds. The Angiosperms owed much of their evolution to bacteria, fungi and insects, from all of which they had received important symbiotic services. The presence of the Angiosperms, with their vitalised seeds and fruits, in turn facilitated the evolution of the highest animals, the mammalia, distinguished by a high type of parental sacrifice and, concomitantly, by longevity and real dominance. Like the Angiosperms, the mammalia excelled in Symbiosis and in gestation.

Plants and animals have thus evolved *pari passu* along many parallel paths. Darwin pointed out that after long intervals of time the productions of the world have changed simultaneously. And so they have. The good organisms progressed along a definite path, mainly that of progress in mutual usefulness and mutual elevation of status. The best of the plants helped to elevate the best of the animals, and *vice versa*. The bad organisms changed together in an opposite direction, some becoming parasites, and others, in turn, corresponding hyper-parasites on these. Even if we left all specifically moral distinctions out of account,

there would still remain a real difference between "higher" and "lower" type of organism, which is not identical with the mere difference between that which can persist and that which cannot. One cannot decide what is "higher" by merely deciding what will maintain itself for a great length of time. We require reference to some genuine hierarchy of beings, such as based on definite values. Such a scale is clearly discernable along the lines of that symbiotic scheme of evolution such as I have so far formulated. Those who are the best partners, the most efficient workers in furthering the scheme of co-evolution, are those who can claim, and actually occupy, the highest rank. Those who, on the contrary, tend most to frustrate the scheme are those who sink to the lowest level down the inclined plane of life, as I have often shown.

It was Sir E. Ray Lankester who pointed out that longevity is generally connected with a relatively high amount of reproductive expenditure. It is clear from the foregoing that in this particular, symbiotic organisms may be expected to excel. In actual fact, we find that symbiotic cross-feeders furnish the most long-living, most advanced, and most dominant species of animals. The quality of the embryonic food supply here plays a great rôle, and, in the light of modern dietetics, it cannot be doubted that the cross-feeders receive the most direct and auspicious food energies and food stimulations. They receive, for instance, the vitamins at first hand, whilst in-feeders do not. It has been found that in products derived from animals the content of the vitamins is not at all constant, but varies widely, and, further, that animal products are apt to lose their vitamin contents very quickly. All of which is intelligible, seeing that these products contain only residual vitamins. The plant alone possesses the secret of vitamin manufacture and nurture. In the course of digestion, the animal breaks down the vitamins, which during the process, lose much

of their pristine virtues. Hence, those animals that rely chiefly upon animal products are less well off than those relying upon vegetable products. It has been found that lard, for instance, which forms so large a part of the dietary of the poor, is frequently entirely devoid of vitamins, because it has been exposed to the air. The anti-scorbutic vitamin, in particular, is apt to be rendered inactive by atmospheric oxidation. What applies to lard, applies also to cod liver oil. The access of a little oxygen is enough, it appears, to destroy the precariously held vitamin residue to be found in animal products. Deprived of its due vitamin content, food fails of its effects, and may even act as a poison.

The symbiotic cross-feeder, moreover, excels in that it lives in accordance with sane economics. It lives on interest rather than on capital, and it has much more to spare for the purposes of domestic and biological Symbiosis than the spendthrift predaceous organism, which, in a real sense, is all the time robbing itself. The former's co-operative, wealth begetting character makes itself felt all round, just as the opposite phenomenon is observable amongst predaceous species. The cuckoo is a failure, both in domestic and in biological virtue. It is a stark and obese in-feeder, and the female shirks the brooding sacrifice. Its specialisation has been increasingly along the path of criminality. It is an outcast amongst birds. Few would be bold enough to envisage progressive evolution for such a creature. Bird life would soon come to an end if all birds were in behaviour like the cuckoo. To say that the Darwinian attempt to explain the case of the cuckoo borders on the ludicrous, is certainly understating the case. What is usually given by way of " explanation " is such utter folly that only a university pedant could be content to continue going on with such a system for a single day. As a rule it is attempted to prove that the cuckoo derives some " profit " from its criminality. If a thief, or a murderer, derives a " profit " from his misdeeds, then, according to Darwin

ism, he is engaged upon a normal adaptation, into which no element of abnormality or of pathology enters, and which is perfectly sanctioned by Nature. The amazing thing—the most disquieting symptom of our time, as Samuel Butler rightly emphasised—is that the world allowed itself to be hoodwinked by the promulgators of such a fraudulent and sterile system, and that its professors should be allowed to browbeat those who have provided an infinitely better and more valuable interpretation of the evolutionary process. Dean Inge reminded us the other day that the chosen instruments for the foundation of the Christian Church were not religiously gifted persons, and it would seem to be not very dissimilar with regard to those engaged in the foundation of a new biology. "Scientifically minded" people seem to be incapable of the requisite inspiration. They can only fulminate against those who possess it.

So far as "variations" and the influence of food are concerned, we may say that the good organisms yield positive variations, such as are marked by a gain of important factors; whilst the bad yield negative variations, showing losses all round. There are thus two distinct and opposite pathways of evolution, as I have, indeed, often shown.

Let us consider further illustrations of this important truth. I might cite the case of the plant-animal Convoluta. There is a marked contrast between the two species studied by Prof. F. Keeble as instances of Symbiosis. Whilst *Convoluta roscoffensis* is a modest cross-feeder and, by comparison, a slow breeder, *Convoluta paradoxa* is less regular in its habits, less reliant upon mutuality, less abstemious. On the contrary, it is markedly omnivorous, and its large surfeited eggs hatch with extraordinary rapidity. *C. roscoffensis* is gregarious, *C. paradoxa* solitary. During the very important period of egg maturation, *C. roscoffensis* remains above all temptation to devour anything. It has a garden within, in the shape of (seasonal) vegetable partners (green algæ), which, however slowly and mildly, provide food and stimulation, ideal for reproductive purposes.

Convoluta paradoxa, on the other hand, is a glutton and throughout life an immoderate and promiscuous feeder. It shows less forbearance towards life than its gregarious relative, and concurrently—such is the socio-physiological sequence in these matters—it affords an inferior quality of embryonic food-material, detrimental to the evolution of the species. It affords food good enough for solitariness, but not for gregariousness, a matter of the utmost importance in evolution. The surfeited embryonic nutrition, provided by a gluttonous species, like *C. paradoxa*, is calculated to determine offspring in a pathological rather than in a wholesome sense. It means disease, just as obesity means disease. And just as obesity shortens life, and is apt to induce precocity of offspring, so the precocious maturation of the eggs of *C. paradoxa* must be envisaged as a loss, a curtailment of embryonic nurture, with resulting reduction of the span of life and of status. A non-surfeiting, more slowly and more mildly stimulating embryonic nutrition would, on physiological and evolutionary grounds, be perferable. I may say that whilst the colour of *C. roscoffensis* is green, indicating a widely availing Symbiosis, attended by an optimum of photosynthesis, that of *C. paradoxa* is brown, showing an inferior Symbiosis; and it has recently been found that in a similar case of plant-animal partnership, *e.g.*, in Hydra, the brown variety is a pathological one. I could easily multiply instances of this kind, showing that disease ensues with inferior feeding habits.

In the matter of reproduction, a profligate species meets with its *ne plus ultra* of biological transgression. Offspring, however embryonic, require to be fed, *i.e.*, served; and a species unaccustomed to service generally, is not one likely to provide the best food for offspring. The more it becomes habituated to theft and murder, the less felicitous will it be in the service of offspring. It will be unable to endow offspring progressively. Because such sequences are not noticed by the orthodox, committed as they are to mere mechanism, it does not follow that they do not exist. and are not

of the utmost importance. It is the height of narrow-mindedness to think that there is only one way of viewing things biological. We may say that a predatory species, despite its "profits," derived from theft and murder, is in the matter of heredity checked by negative compensation, as exemplified most drastically by the case of parasites, amongst which cases of reproductive nemesis and of loss of important structures and faculties abound.

It would be strange, indeed, if there were not a correspondence between metabolism and character, if, say, the metabolism of a predaceous species did not deteriorate *pari passu* with the decay of character. The facts of Nature bear out my contention, although they have not received the attention they deserve. It is a fact, for instance, that the whole trend of evolution has been from solitariness to gregariousness, with the corresponding changes of feeding habits. Compared with the non-predaceous, gregarious species, the predaceous solitary ones are always backward and pauper-like. There is every evidence to show that the social states of the insects, in order to be truly successful, must be based on a vegetarian diet. Such a diet alone, it appears, can furnish the mighty basis for the wonderful super-structure presented by healthy flourishing and efficient social states of organic creatures. In the absence of such a beneficial physiological, and economically legitimate, basis of life, the development of the insect states would have been impossible. On a vegetarian basis alone can true gregariousness be achieved in Nature. The beasts and birds of prey, the serpents and spiders, the legions of predaceous insects, all lead solitary lives, whilst the herbivores, rodents, graminivorous and frugivorous birds and plant-eating snails and insects are more or less gregarious. According to Prof. Wheeler, of Harvard, the ants, in particular, exhibit a progressive tendency to resort more and more to a purely vegetarian regimen, as the only means of developing and maintaining populous and efficient colonies. What is more, after

an exhaustive study of the evolution of the famous social states of the insects, he says that the facts force even those who, like himself, are not vegetarians, to confess that the trend of evolution in the most interesting of social insects is towards ever increasing vegetarianism. In earlier times, the ants show less evolved gregariousness. No wonder, they subsisted then, predaceously, on a fleshy diet, being more carnivorous. What a sidelight is here thrown on the causation of cancer, due, as I hold, in the main to our carnivorous habits. Pathologists tell us that the cancer cell presents a case of "reversion," that is to say, the cell, instead of conforming to a high and evolved degree of mutuality (as evinced by, say, the sociality of the gregarious, vegetarian, social insects) tends to return to the license of a more primitive existence, with less developed mutuality (as evinced by primitive, carnivorous species).

It is a gross understatement of the case to say that the success of the vegetarian diet, in fostering progressive sociality and progressive evolution, depends on the greater abundance of such fare in Nature. I have often shown that it is in the first place the great evolutionary adequacy of such food that counts for most in this matter, and that, indeed, the very abundance of the right vegetable food depends, in turn, on adequate counter-services rendered by the animals to their food-plants, as the example of the ants and bees, etc., cultivating their own food-plants, copiously shows. There is co-adaptation and co-evolution between animals and plants, and in their respective inter-relatedness those feeding habits which are economically and morally the most in conformity with the grand rules of the scheme must also be the most legitimate and the best. It is misleading to say, as is sometimes done, that predatory insects, such as the wasps, for instance, show equally high development with the purely vegetarian hymenopterous species, *e.g.*, the bees. The wasps are omnivorous highwaymen. But, as I have elsewhere shown, they cannot vie with

the bees so far as real evolutionary success is concerned. And even the social wasps, though descended from highly predaceous ancestors, according to Wheeler, are becoming increasingly vegetarian like the bees. Compared with the bees, the colonies of the wasps are lacking in permanence and care and in social achievement. They are the scenes of great tragedies, reminiscent of the cancer tragedy among us—fatalities largely avoided by the vegetarian bees. Not only are predatory organisms in Nature, as a rule, non-gregarious, but they also exhibit the selfsame cannibalism that marks the cancer cell—so that the analogy helps us the better to understand the pathological element in the make-up of all predaceous creatures, their case belonging to the seamy side of biology.

I have given innumerable examples of cannibalism among predaceous creatures in my various writings. Members of carnivorous species devour one another—females the males; parents the children, sons and daughters their brothers and sisters, or their cousins, as the case may be—a truly ghastly tale, but wonderfully instructive. Had these facts been collated hitherto they could hardly have escaped the attention of science. Without realising the profound significance of the phenomenon, naturalists have from time to time been compelled to bear testimony to the striking contrast which exists in the results of cross-feeding and in-feeding habits. There are insects of the notorious Mantis tribe, for instance, presenting an appearance of innocence and quietness, which, however, is of the most deceptive kind, for the activity of the creatures consists of a series of wholesale massacres, carried on day and night, the number of victims being enormous. "They do not spare their own kind," says the "Cambridge Natural History."

Here is another illustration of the seamy side of biology, of the in-feeding and "cancerous" phase of life, of the realm of morbidity and of degeneration generally.

The lesson afforded, by way of contrast, by vegetarian species was not altogether lost on the writer in this same "Cambridge Natural History." Says he: "This voracity and waste of animal food (on the part of Mantis) is very remarkable when we recollect that many insects have such perfect power of assimilation that during the entire period of growth they only consume a mass of food—and that vegetable—(sic) but little larger in size than the bulk they themselves attain. This fact is well-known in the case of *Bruchus*, *Caryoborus*, and other seed-feeding insects."

How different the picture when we approach the cross-feeding, symbiotic pole of life! The usual prejudice is that vegetable food is "highly innutritious," hence it astonishes this writer that cross-feeders should yet want so little of it (and, should moreover, on such frugal fare develop a much higher character and status than the voracious in-feeders).

The evolutionary significance of food has entirely escaped the schools. Usually we find the frugal class of organisms engaged in symbiotic services to their food-plants, thus furthering, in a truly economic and synthetic manner, the grand scheme of co-evolution between animal and plant, and fulfilling a truly evolutionary mission, whilst reaping the reward of progressive organisation for themselves. Truly, interpretation is to-day more important than research. The lesson of Nature is written indelibly on the pages of Natural History, showing that the obtaining of a satisfactory degree of organic association, with high degrees of life partnership and of division of labour, together with exaltation of type, depends, in the first place, on nutrition. The best nutritional basis is afforded by "cross-feeding," (that is, feeding on the spare products of the co-evolving partnering "kingdom" of Nature). In-feeding is inferior, since it fails to supply a basis for progressive life. Organic units, be they independent or semi-dependent, cells, or tissues, or organs, or organisms, when on a carnivorous diet, show little tendency to integration, to fruitful or progressive association with

others, but tend, on the contrary, to disintegrate and to exhibit a sundering of associative ties, just as we find, in a badly managed political state, the bonds of society tending to snap asunder, producing disintegration. Things refuse to be mismanaged long. It has been found that cancerous growths rapidly produce substances which are detrimental to themselves, although they are not detrimental in the same degree to normal tissue. They make the fluid in which they grow unsuitable for further multiplication, this again illustrating the deterioration of the metabolism in predacity.

Although Darwin failed to present us with a theory of behaviour, and to the end remained puzzled by the phenomenon of extinction, yet he adumbrated that liability to extinction may perhaps be due to lack of improvement according to the principle of the all-important relations of organism to organism in the struggle for life. Broadly speaking, this hint now proves correct. And the principle—not known in Darwin's days—which failing species are thus setting aside to their doom, is precisely that of Symbiosis, the principle of reciprocity in co-evolution.

The " co-adaptation " between plant and insect is often very close. It is a well-known fact that amongst butterflies variations may be induced by a change of food-plants, by a change from grass, to, say, large-veined leaves. Flowers, as Weismann stated, produce their scents in order to attract their visitors ; and the male butterflies produce the same, or at any rate similar, scents which attract their females. All of which shows how closely the symbiotic approximates to a genetic relation, both in significance and in value. Partnership is the important factor, be it in sex or in Symbiosis. Darwin has shown that the original insignificant blossoms of the phanerogams owe their gradual transformation into real flowers to insect visits, whilst many large orders of insects, as a result of their visiting plants, have been gradually modified. Especially bees and butterflies have become what they are to-day as a

result of their intercourse with flowers. All of which, if it be "co-adaptation," is also pre-eminently co-evolution.

The Leguminosae are conspicuous for the wealth of their symbiotic relations. *Inter alia*, as is well known, they harbour nodules, consisting of nitrifying symbiotic bacteria, upon their roots. What I would particularly stress in this connection is the healthiness and success of this widely useful and highly symbiotic order of plants. The viability of ordinary leguminous plants, such as clover, for instance, is very great. They will grow in bare places, provided the right minerals (for cross-feeding) are obtainable. On land so poor in humus and nitrogen that practically no other crop will grow, sweet clover thrives, and, what is more, it will enrich the soil, making it ready to provide for the protoplasm of other plants. The Japanese clover, *Lespedeza*, has been the salvation of hundreds of thousands of acres of land all over the Cotton Belt of America. That it has been vigorous enough to oust all harmful weeds, speaks volumes for its viability, but it also testifies to the fact that in the long run fitness and resistance follow in the wake of Symbiosis. Prof. Troup emphasises the wonderful powers of recovery on the part of the roots of many leguminous Indian plants. Frequently, although they are almost wholly eaten away by animals, they will send up their shoots from the portion left untouched. This power of recovery, he says, renders the seedlings very hardy, for, although they are liable to be killed by frost and drought, they almost invariably produce new vigorous shoots from the base.

There is a great lesson of health in all this testimony, to which nothing similar is to be found anywhere in Darwinism.

In symbiotic relations which are normally healthy there comes the possibility of a partner playing traitor by taking undue advantage of its favourable situation. This inevitably leads to disease and degeneration. Thus disease is seen to be essentially due to anti-

social action. The "evil" uses of Nature are original "good" uses gone to bad, a fact which it is very necessary to remember. Symbiotic partners must be of high integrity, or disorder will ensue. The good life is never an easy life. Pathology is to a large extent made up of idleness or of moral failings.

Disease is, more often than not, a synonym for sin, or, in a biological sense, a contravention of the law of co-operation. Evolution, by the same reasoning, imposes and maintains certain standards of conduct, which, on the only sensible interpretation that we can place on the facts, involves quasi-moral issues. Even in the lowest forms of life we find some adumbration of that morality which is possible in its fulness only in human society. Organisation itself is a monument to dutiful integration, and this requires integrity.

Darwin opened our eyes to the facts of descent. We have now to learn the equally important lesson of the gradual enfoldment during "descent" of the moral imperative. With "descent" there goes the idea of the kinship of life, and in view of such kinship and of the common experience of life, we need not hesitate to apply certain human concepts to the lives of animals and plants, so long as we make due allowance for differences of degree. The charge of "anthropomorphism" need not deter us ; for no explanation of the organic world is open to us save in terms of human mentality. Seeing, moreover, that man is heir to all the ages, thus comprising the experience of most other creatures, we need not be morbidly afraid of translating some broad human conceptions to fit the case of the lower life. Even those who tell us that when we speak of the courage, or of the reason, of, say, an insect, we are in unfamiliar and uncharted regions, will admit that at least an "unconscious education" is the evolutionary heritage of every living creature, and of every living tissue, whilst they also concede that, amongst animals, "higher" anatomical structures and larger and more

complex brains are usually seen to go together, which again is quite congruous with the case of man.

A modern writer on "Animal Mind" states: "In considering animal life, especially animal mind, the early Victorian conception of it as one thing, and we as another, should be rigorously excluded. The better we know ourselves, the better we shall understand the creatures about us."

Even if we confine ourselves to "unconscious education," as the quintessence of evolutionary discipline, this is compatible with the idea of an evolution of morality, begun in animal and plant life, and continued into the human without a break.

We may say that, in view of the kinship and the primeval and perennial inter-dependence of life—involving, as they do, identical contingencies and necessities of life—here as there much the same general lessons of comportment had to be and, speaking restrospectively, have been, inculcated.

From much the same organic necessities, and, no doubt, also because of some underlying constitutional laws of the universe, organisms had from the first to be drilled into what might be called "gentlemanly" habits. That is to say, they could not altogether go as they pleased, for some ways were preferable and better than others, and the superior ways it was that conduced to success in evolution. Instead of constant reiteration of an undefined and metaphorical "struggle for existence"—another way of saying that success is due to muddling through somehow—it is now for us to discover the precise degrees of restraint and of unselfishness which most felicitously conduced to evolutionary progress, and to specify the kinds of unrestraint and of selfishness which entail the undoing of evolution.

Broadly viewed, the respective lines of behaviour are now clearly discernable, just as concurrently the general plan of co-evolution is now discernable. But it does not follow that, having made such general recognitions, we shall immediately be able to attribute this or that "intention," or "design" to every act of, say,

an insect. Enough, for the present, if we can discern more clearly the value and significance of the agelong drilling, the discipline, of the evolutionary process, and learn to shape our own course accordingly, Samuel Butler submitted that the "fittest" originated from organisms whose variations arise mainly through use and disuse, from variations into which a moral and intellectual system of payment according to results largely entered. "If we admit," he stated, "that to some considerable extent man is man, and master of his fate, we should admit also that all organic forms which are saved at all, have been in proportionate degree masters of their fate, too, and have worked out, not only their own salvation, but their salvation according, in no small measure, to their own goodwill and pleasure, at times with a light heart, and at times in fear and trembling."

This is also my view, and it seems to me to be the common sense of the matter. It equally seems to me that there is not much room for anything else beside common sense in the interpretation of the facts of evolution. Butler's view merely needed to be worked out more fully to permit of an entirely new interpretation of the evolutionary process, such, for instance, as I have attempted in my endeavour to fit physiology, sociology and ethics into one co-ordinated scheme.

Chapter I.

The Argument from Geology.

It is now clear that some of the points of my Darwinian critic in "Nature" are fairly answered, and that his chief difficulty with my views is due, not to a misrepresentation of Nature on my part, but to his being accustomed to the wrong picture of Nature. In their anxiety to ape physical science and to render biology mechanical, Darwinians have taken all that is most valuable out of the picture and have made a travesty of "Evolution." So far is it from true that Darwinists have presented us with the true picture, that they have not even attained to a conception of the normal phase of life. They have perversely taken the abnormal, the dark side of life, for the normal. They have presented us, in the terms of a great philosopher, with the "night view" of Nature, whilst omitting the "day view." In so doing they have caused an enormous amount of mischief and distress. A truly Herculean effort is now needed to clean the Augean stable that Darwinism has bequeathed to us; for there is hardly an issue in the modern world that has not been perverted by the teaching of Darwinism, whilst the people have become so inoculated and saturated with the falsehood, that it is not easily eradicated. Nothing short of a crusade is needed to destroy this clumsy fraud of Darwinism. Hence, too, although I have already taken a considerable share in this cause, I feel I must not grow weary in well-doing, but must pursue the argument further, until it is widely realised that we are entitled to the fair "day view," and to be rid of the "night view," which has blighted our thought and obstructed progress in many directions.

Let us now compare the symbiotic picture of the world with that recently drawn by a geologist. In his presidential address on "Geology in the Service of Man," Section G. (Geology) of the British Association at Toronto, ("Nature," 11/10/24), Prof. W. W. Watts, F.R.S., tells us that we know enough of the past history of the world to convince us that within post-Cambrian time evolution has steadily proceeded from general to special, from simple to complex, from lower to higher efficiency.

There is practical unanimity in all the evolutionary camps so far as this generalisation is concerned. Yet the question remains, wherein does "efficiency" consist? Is efficiency for murder on a par with efficiency in Symbiosis? It is certainly the considered opinion of orthodox biologists—so far as they concede a contrast, or even a difference, between symbiotic and carnivorous "adaptation" at all—that the two kinds of efficiency are on a par, than which nothing could be more fallacious. The question is, which kind of efficiency pays best in the long run and conduces most ideally to exaltation of type? As to that, the present volume, I hope, will leave no one in doubt. A study of Prof. Watts's paper very soon renders it apparent that he finds himself, as a Darwinist, able to envisage only a very superficial division of organisms, namely, roughly, into two groups: the attackers and the attacked. Sure enough there were attackers, as there were also attacked—life being frail, the temptation to short-cuts, to abuse of power, having presumably always been present, and with it the universal necessity for defence.

But, when this is granted, our geologist gives still too meagre a catalogue of evolutionary divisions, one not at all adequate as a representation of the mighty forces that operate below the surface of things and form the mainstay of the great drama of evolution.

There are other, more profound divisions, representing more fundamental and more venerable constituents, regarding which Prof. Watts's account is silent. There are divisions constituted by differences having

regard to associative and bio-chemical factors, for instance. "Descent with modification," as Prof. Bateson reminded us, is largely a chemical process, and of the principles regulating that chemistry, according to him, science has had hitherto neither hint nor surmise, although, as he said, some have been talking glibly about it, adding: "What glorious assumptions went without rebuke, professed men of science offered very confidently positive opinions . . . . which would now scarcely pass muster in a newspaper or a sermon."

We must dig deeper than geological appearances, and even deeper than bio-chemical appearances, in order to understand so mighty a movement as evolution. We must give its due above all to the genius of organic life for mutual accommodation; remembering in particular that it is most generally the co-operative method that has rendered the chemical resources of the world progressively available for the purposes of evolution. We must look to synthesis, synthesis superposed upon synthesis; nor must we be oblivious of the fact that in this mighty pyramid-building of syntheses, virtue, too, has had a share, as she, proverbially, also takes her seat with freedom. For, broadly envisaged, and in the light of the all-important fact that man (with his values) has practically become the arbiter of organic life, what has been the purport of evolution if not the gaining of a higher freedom—the freedom that is most compatible with law and righteousness?

The syntheses that were chiefly of avail in progressive evolution, as the study of Symbiosis clearly evinces, were those constituted by systematic and elaborate services of organism to organism. The operation of the principle of "use and disuse" seems "natural" enough to most biologists. They forget that even here they are in reality dealing not so much with a mechanical, as with a socio-physiological principle, according to which, service, by way of reaction and reward, entails an increase of the power of the server, whilst lack or lapse of service involves a loss of powers.

I have often shown that the "good" classes of organisms, by their useful activities, tend mutually to elevate each other, which is more than could be claimed for the community of the predatory classes. True though it be that evolution exhibits some progress in the efficiency of depredation, this is also in a most important sense a progression in a suicidal course, as is very aptly illustrated by the fact alone that very frequently carnivorism is but a halfway house to parasitism, which latter means entire ruin. "We are as a race more fortunate than our ruined cousins—the degenerate Ascidians," says Sir E. Ray Lankester, thus acknowledging the disastrous issue of a once predatory, and subsequently sluggish, parasitic career.

Add to this that pathology is as yet but in its infancy, that on due enquiry it will be seen that "in-feeding" is the very *fons et origo* of infection and of loss of resistance, and the idea of the evolutionary "efficiency" or "fitness" of predatory creatures is seen to be a mere chimera, clung to partly from the need of justifying our own predatory instincts. It is a fact, moreover, that the predatory are those who, on the principle of the abuse of power, have recruited themselves from time to time from the ranks of the honest species. The fundamental endowment of the said predators is due in the first place to the activities of non-carnivorous ancestors, the patrimony of which is now being gradually consumed at the expense of status, concerning which more will be said on another occasion. The ancestors of our carnivores, for instance, were the creodonts, most like our present bear tribe, the least carnivorous of their order.

Hence, if we meet with ever more perfected "attackers," this does not mark the triumph of an actually surviving, but rather of a recurrent, carnivorism, a secondary result, incidental upon the advance of "organic civilisation," which, through laborious syntheses, through altruistic service, engendered ever new powers, which powers could on occasion be deflected into channels of evil. In other words, the carnivore

arise *de novo* on the principle of *corruptio optimi pessima.* There is nothing much new to be produced that way. Rather it is a return to something primitive; and carnivora usually "converge," giving the appearance of being in line of ancestry with one another at different periods and in totally different localities, though, as a rule, they are not. They are merely birds of a satanic feather. Progressive evolution is produced by totally different means, by the summation of powers in co-operation, which is a totally different thing from depredation. There is evidence to show that the powerful beak of the bird of prey is in some instances due to the exertions of a nut-cracking avine ancestry; whilst the strong tooth of the carnivore may have been due in the first place to the nut-eating propensity of a purely cross-feeding ancestry. The case is paralleled by the evolution of human warfare, which would not be as perfected as it is to-day, had not Mars been constantly able to borrow from the arts and resources of peaceful endeavour.

I am not arguing, of course, that the carnivora are totally useless; one must give the devil his due. They have a certain usefulness as bullies, checkers, scavengers and executioners. My point is that theirs is an inferior adaptation, from the point of view of co-evolution, and that for many reasons such adaptation as theirs must always be more or less precarious, until, ultimately, it finishes by being altogether fatal. They are condemned to intense rivalry and internecine warfare, since they do not tend to increase their means of subsistence, and it is, therefore, obvious that from ruinous necessity their numbers must be kept down much more rigorously and remorselessly than those of the cross-feeders, so much so, indeed, as to preclude the development of a progressive social state from amongst their ranks. Hence, too, they cannot vie at all with these so far as the advantages derivable from the social life—sympathy and intelligence—are concerned, and they can never, for the same reason, hope to attain to real dominance, which advantage lies in the path of the socially educated organisms alone.

All those who have given attention to the matter have come to the same conclusion, namely, that social animals are more intelligent than the solitary The high intelligence of tailed monkeys is attributed to their social habits. The solitary, non-social lemurs are on a much lower mental level than monkeys. Social life, as it exists among the primates, for instance, stimulates mental activity and has an educational value : the solitary lemur or the tiger enjoys neither of these advantages. Their very psychology condemns the carnivora to inferiority. Picture to yourself the kind of mental processes which we may fairly presume to occupy the subconscious mind of a carnivore, say, a tiger—lying in wait for hours or days, with nothing to occupy its mind but blood thirst, the craving for ferociously pouncing upon some other creature, for breaking its neck, tearing open its entrails, and gorging itself with its flesh and blood ; possessed of the passionate desire to kill, and ever again to kill, except for the hours of leisure, when the beast lies replete and idle by the side of the kill until the recurrent impulsion of a mad hunger drives it forth again on the same sanguinary and sterile pursuit. Needless to say, the respective satanic " complex " becomes more intensified with time and with heredity, to the ultimate deletion of nobler strains which once existed in the species. It is evident that under such conditions any refinement, if ever there was such, must gradually atrophy, just as structural atrophy is the goal of carnivorism on its further degeneration into parasitism. The contrast with the case of a symbiotic cross-feeder, say, an ape, or a squirrel, or a parrot, is so great that only one who is wilfully blind to the facts can fail to see the moral.

Prof. Watts tells us that in almost every subdivision of the animal kingdom, and in not a few branches of the vegetable kingdom, lines of descent and directions of specialisation have been made out, sometimes visibly operating throughout whole systems, but more usually through smaller divisions of the

record; and this in the former kingdom occurs not only among vertebrates but also among the invertebrates and even their lower sub-kingdoms. "It may even be stated that in methods of food procuring, in the attainment of favourable positions and attitudes, something very closely imitating what would be expected on the doctrine of the origin of species by 'survival of the fittest' has again and again occurred."

There is little real cause for exultation on the part of Darwinists over this apparent corroboration of their theory. Let me remind them that, as the French say, "*dans le royaume des aveugles les borgnes sont rois.*" In other words, if it may be said that Darwin still reigns supreme, this is for no other reason than that the professional biologists lack the talent to see further, and that they ostracise him who does. In spite of all that we learn to the contrary from the geological record, even on Prof. Watts's showing, the facts can be far better interpreted for "Evolution by Symbiosis" than for "Evolution by Natural Selection."

All that our geologist really means to say is that the facts would seem to warrant the conclusion that "some such" principle as Darwin's, i.e., one having regard to interaction of life (how much so being left open to conjecture) must have been involved; and, having no other to turn to, he invokes the orthodox principle, though not without reservation. In so doing he is in fact relying on the "X" factor, which, as was shown in the above, commits one to nothing in particular. He is making use of a principle which, as I have demonstrated, has the doubtful merit of depicting the morality of Nature so near to zero, as to make normal and physiological developments undistinguishable from the abnormal and pathological, thus identifying biology most unduly, and most infelicitously, with physical science.

Prof. Watts's reserved adherence to "Natural Selection" is evidently a case of facile acquiescence in —rather than deliberate acceptance of—the principle. As a convenient shield of ignorance, shelving much

uncongenial study, the Darwinian principle has, with what justification the reader may now see, been called a "good working hypothesis"; and, in a sense, it is that so long as no critic arises to insist on further explicitness with regard to the implications, and so long as no modern Socrates arises to expose the sophistry on which the hypothesis rests. A more pronouncedly social theory, although it might remove the aforestated handicaps, would do away with the mechanical pretension, much to the detriment of the prestige of the fraternity who proudly boast to stand, as scientists, beyond good and evil; and to adopt such an unconventional principle would certainly not be the way to be popular amongst the present coterie. Should Prof. Watts lean on some new and unauthorised, or "verbotene" principle, this might land him in all manner of difficulties, including those of getting entangled in matters that lie beyond the range of his own specialism. Enough if he walks warily, and practically confines himself to the hint that a clue to the mystery of definitive evolution, to direction, may be found in the study of a neglected but unnamed principle which makes for ever-increasing efficiency amongst organisms. Let us travel hopefully! Some detailing must surely be left for a future generation of professors. We see then in what sense rhapsodists and fanatics are correct in declaring that the Darwinian hypothesis has been "proved" and "attested" "over and over again" by every scientific authority, as they say—in a pusillanimous sense. The authorities are timid of innovation.

Often have I shown that it was a more comprehensive synthetic process than "Natural Selection," namely, Symbiogenesis, which gave due direction to evolution. I am glad to find that Prof. Watts is able to re-emphasise the fact, for which there exists other evidence, of the simultaneous trend of evolution in both the plant and the animal kingdom. These parallel paths, I again submit, were not at all unconnected with each other, but they formed part of a grand scheme of symbiotic evolution. On due

scrutiny, it will be seen that those parallel lines of modification and direction, observed by geologists, tell a tale of mutual aid, rather than of mutual encroachment. Along the lines of trial and error, the co-operative method has definitely established itself, proving of immense survival value. Symbiosis is as old as the hills. It is not that nature, in order to discover an economically sound principle of association, had to wait and then to copy and imitate the methods of man. Examples of Symbiosis have been traced down to the Devonian and lower coal measures.

Efficiency has, indeed, been a masterword of evolution. But what it implied was this, that waste and wasteful methods had to be progressively avoided. The progressive elimination of wastrels—that is the elimination to which I would especially call attention. If what may be called "Natural Elimination" has worked with consistent reference to the good of all, this is precisely for the reason that co-operation in the first place so acted, as I have often shown. Elimination in one form or other it is that overtakes those elements which no longer co-operate efficiently, much the same as it does in human society. For the same reason, the wasteful predatory organisms could never have been on a par with the useful, symbiotic and economic ones. That economics must come in here will be gainsaid only by those who assert that economic law does not operate now as it did in the past, or by those who, having first surreptitiously smuggled in economics by a side-door, to wit in the shape of "competition," subsequently repudiate economics, in the shape of co-operation, when this would tend to destroy the pretence of a mechanical theory. Such as these usually attribute their own inconsistency to Nature. How unlikely it is that Nature has ever been different, or inconsistent, in her fundamental methods, may be gauged from Prof. Watts's admission that, as with antiquarian research, each new discovery in geology, whether on the physical or the biological side, only brings these distant ages more fully into view

and emphasises their modernity and their likeness to our own time.

Were Prof. Watts to commit himself more definitely to a purely mechanical theory of evolution, he might get into similar difficulties with critics as I fell into with G.P.B., even with the distinctly non-mechanical theory which I propounded. For he re-emphasises the principle that the use of defensive armour, spines, plates, hooks, horns, etc., as practised by one group of organisms after another, has been followed by the same disastrous result, the imposition of a fatal strain on the organism to meet renewed, perfected, and more vigorous attack. We have here an important parallel principle to the one I have enunciated with regard to feeding practices, expressed in the aphorism that "Nature abhors perpetual in-feeding." And we have here also a significant parallel, if not an identical conclusion, namely that, although certain habits, or practices, may be widespread in Nature, and may have been tried again and again, and on a fairly large scale, yet the respective activities may be in an important sense *contra Naturam*, or, at any rate, comparatively inferior. My writings are replete with evidence of the presence of weak or fatal strains in the composition of carnivorous creatures, condemning them to calamities and to a state of inferiority. Shall I again give a striking instance of weakness, morbidity and liability to infection and to cannibalism among carnivores? The mole is a typical "in-feeding" quadruped. It is excessively voracious. It can endure no long intervals between meals, hunger soon ending in death. When pressed by hunger, it will attack and devour even one of its own kind, and its practice is immediately to tear open the body of any bird or quadruped which it has killed, and, inserting its head, to satiate itself with the blood. The moribund creature, which may be killed by a slight blow, is thus indulging in the very methods by which (infectious) diseases are transmitted, and by means of which the respective pathogenic adaptations are being per-

petuated in a vicious circle of affinities. When plague is transmitted by fleas, it is in the sucking of the (infected) blood into their stomach that the plague germs are enormously multiplied within them.

The flea, the rat, the gross flesh-eater, these are the ones to constitute a vicious round of in-feeding, they are the perpetuators of the forces of destruction, the appropriate subjects of Nemesis.

> " Shall they not rise up suddenly that shall bite thee, and awake that shall vex thee, and thou shalt be for booties unto them ? "

If Prof. Watts had had a G.P.B. appointed to criticise him, the critic would probably have urged that if his rule with regard to the failure of the defensively armoured organisms were correct, there could not be the present survival of the turtles and armadillos, since, by hypothesis, " Natural Selection," allows no unfitness to exist. Prof. G.P.B. thinks it necessary to warn those who might, as he says, admire my book, that " sharks are older than land animals, and carnivorous echinoderms older than sharks ; that most animals live in the sea, and of them nearly all larger than a ricegrain are carnivorous ; that beautiful fish are not less predaceous than ugly fish ; and that the production of thousands of eggs for one to survive is not " a form of disease and penalisation," but is a repetition of an ancient marine habit still followed by most female animals, and by all males."

This is a garbled account of life, contrary to the principal facts, as we shall presently see ; but it is the criticism of a fanatic, out at any price to prejudice the reader against my views. This amiable gentleman is probably quite honest in thinking that any evil that occurs fairly universally thereby ceases to be evil and becomes normal and legitimate. Even a fanatic (had he not been appointed to traduce me) might have had the decency to confine himself to the remark that although my rule may hold good in some cases, it is doubtful whether it would in others.

How does Prof. Watts anticipate those who would point to the present survival of turtles and armadillos as cancelling his principle? He tells such that the survival of these species rather endorses than vitiates his principle. Evidently an evolutionary thinker must be one to realise that there are exceptions to almost every grand rule, that any newly discovered rule must not hurriedly be rejected because there are apparent exceptions to it, and further, that in matters of this kind it requires considerable acumen to perceive clearly how far a new rule may be, or may not be, traversed, or on the contrary, endorsed by the apparent exceptions.

More particularly is it true, that a reserved attitude is required when it is remembered that disease and extinction have remained mysteries to the schools, and that there is no unanimity amongst them on almost any issue. Organic life presents an exceedingly complex structure, so much so as to allow many intrinsic weaknesses to be camouflaged into giving the opposite appearance, and this, maybe, for long periods of time. A socio-physiological "law" of evolution, moreover, does not, as a mechanical, Darwinian, principle supposedly does, control phenomena with the automatic rigidity of a machine; rather is it a generalised statement of the way in which phenomena are observed to occur. When one says that law and order exist in the universe, one means only that we have discovered certain uniformities common to a number of phenomena, and one expresses these uniformities in the form of law. If Prof. Watts's principle were a purely mechanical one, acting like, say, gravitation, or denudation, *i.e.*, inexorably throughout every nook and corner of the globe, there could scarcely have been the survivals that we see; for the "fatal strain" would have proved still more calamitous with the more advanced type of modern attackers, than it was thousands or millions of years ago. But if we view evolution as preeminently a socio-physiological process, then it is clear that a certain latitude must be allowed for exceptions; for benefit rather than mechanical uniformity is the end

of organic Nature. If, for one reason or another, the appropriate attackers are not at hand, being, let us say, busy elsewhere, we may, and we do, get many remarkable survivals of impoverished and sluggish organisms, anachronisms of all kinds, and, frequently, of considerable numbers. Efficiency is a relative concept. Efficiency for evolutionary thinking, for instance, makes to-day much bigger demands on mentality than it did in 1860, when all was simple, and omniscient gentlemen abounded. Those who would abide by ideas of 1860 are the living fossils of our time.

The fact in itself of the survival of carnivorous species is quite compatible with the idea of their life being based on an inferior principle, just as the fact of the survival of turtles and armadillos is compatible with Prof. Watts's generalisation regarding the comparative inferiority of highly armoured creatures. Certainly it is true to say that lions and tigers are becoming attenuated in numbers much in the same way as Prof. Watts' inferiors—the turtles and armadillos have become reduced—whilst of the smaller kinds of carnivores it may be correctly stated that many of them are at any rate frugo-carnivorous, and thus stand with one foot in the other camp. It is no argument to contend that the decimation of the big carnivores is due to the action of man, as though he stood outside the biological community. The undeniable fact is that to be carnivore is to incur the inevitable and chronic hostility of the best and highest organisms, whilst inviting infection and malignancy on the part of the worst—a very damning position to be in—for it spells elimination and disease.

Prof. Watts concedes the importance of interdependence of life, and he speaks of the securing of the advantages of a "fair field" for the survivors of certain species. How have the plants, for instance, "weaker vessels," though they be, and exposed, without being able to run away, to every kind of encroachment, succeeded in securing a "fair field" for themselves and their offspring? Surely through

service, through increasing efficiency in service—service, moreover, that can here clearly be seen to have been of wide bio-social and socio-physiological avail to life generally.

Amongst plants it is fairly evident that the wasteful, *i.e.*, parasitic species, have obtained only an inferior field, being insignificant in range and in position.

Among animals, too, when everything is taken into account, the tendency has been for the wastrels to be increasingly penalized and eliminated. The social states of animals present many drastic examples of this kind. As an example of a comparatively mild form of the natural rejection of wasteful creatures, I might cite the delicate adaptation of many plants to the visits of nectar-seeking insects, which adaptations aim, as often as not, at the practical exclusion of non-reciprocal insects. All of this is symptomatic of the fundamental striving after true economy in Nature. Just as there exists a multiplicity of forms of encroachment upon the honest community of life, on the part of the predatory, so there is a great number of ways, direct and indirect, more or less abrupt, or gradual, calculated to meet depredation by countless forms of resistance and of retribution. Volumes could be filled with the respective evidence; and such a collation would, indeed, form a good object lesson in pathology as the opposite to natural immunity. Had the facts been duly apprehended, we might now possess a valid theory of disease instead of having none; and I should not now meet with the kind of opposition that I do. I consider practically all pathology to be constituted by a more or less protracted process of natural elimination in respect of the advance of efficiency and integrity in "organic civilisation."

Among a great many parasites (notably the Lernaeans) the male, who is very small (a case of sexual antithesis of size) hooks himself on to the female, and lives at her expense (internecine parasitism—the concomitant and result of the parasitism of the species)

and the exact parallel to the parasitism of the cancer cell —just as she lives at the expense of the fishes they infest. A case such as this I consider as the very type of pathological development—due to anti-social and merely expedient adaptation, to maladaptation or misadaptation, as I should prefer to call it. This is certainly a legitimate point of view, inasmuch as a good deal can be said for it, however greatly orthodox biologists may differ from me. But let them first produce their theory of disease before they reject my interpretation of the facts. Let them produce their theory of extinction, or, for that matter, even their theory of "status." They have no theory, they have only conjectures, often of the vaguest and wildest sort.

It does not follow that because a race is falling short in biological integrity, it must be forthwith decimated. It may linger, on the contrary, for a long time, though in relative insignificance, relegated to a back seat, shorn of status, so long as it is not too greatly in the way of the honest species.

The bio-moral explanation almost forces itself upon us as we read of the uncertainties and doubts our evolutionists feel with regard to extinction. Thus Prof. Watts tells us that the disappearance of many orders of reptiles will long furnish subject for research by biologists and geologists. It is hoped that the State will supply considerable funds for research; although one might at least expect, as one of the paying public, not to be treated with dogmatic contempt when putting forward a more rational theory than the present (insufficiently endowed) "research" allows.

The professor goes on to say that it may well be that the explanation will often lie along "biological" rather than physical lines, such as those suggested with regard to the graptolites by Lapworth, who pointed out that their disappearance—despite a brave effort of passive resistance—synchronised with the great development of fishes, and the assumption by them of many of the functions previously discharged by the Trilobites."

Comme chez nous, I should say. Exactly as it is in human life, the way to succeed in evolution is to do well, better, best—"variations" taking care of themselves. Trilobites became extinct, somewhat abruptly, it is thought, at the end of the palaeozoic period, and we may well believe that in their case, as in so many others, the better functioning creatures superseded the inferior. The better is the enemy of the good. Providence assists those—"Natural Selection" notwithstanding—that do its work most efficiently. I use these terms advisedly, since it is evident to me that those got on best which functioned best in the sense of co-evolution, i.e., in the interest of the common good of the organic world, as opposed to the fallacious Darwinian idea that it is the "local profit" which counts for most in evolution. The older naturalists, who saw the hand of Providence in every adaptation (whereby they are now held to have made themselves ridiculous) may have gone too far; but they were not so wildly wrong as their Darwinian successors, and they did at any rate no harm to morality, whereas the Darwinians, with their exculpation of crime and immorality, as though these were fully sanctioned by Nature, which is not true, have done untold harm, apart from fatally impeding by their narrowness and dogmatism the advance of the various biological sciences. Emerson knew better than Darwin when he stated that vainly do we aim at a petty end, aside from the public good, our act arranges itself by irresistible magnetism in a line with the poles of the world; for something of the kind applies also to organic Nature. In other words again, the modus vivendi of Nature can best be understood by reference to human society, all the talk about "variations" being at best so much pretence. We are entitled to conclude that, like many other crustaceans, these primitive creatures, the trilobites, have become extinct because they failed in activity and in service. They had become sluggish, and many of them parasitic; and in Nature such backsliding is not permitted without bringing in its train the inevitable consequence of the degeneration of organs

and of functions, whereby the creature is fatally handicapped when it comes to the test of competition, which decides whether the organism is still capable of occupying a place of service in the world. "Atrophy," shouts the specialist, mere "Atrophy." Yes, but what seems mere "Atrophy," in a local, specialised sense, is retribution in a wider bio-economic and bio-social sense, and that is the sense that ultimately matters. Why should there be atrophy when an organism fails to work? Let the orthodox biologist answer, or ponder, that question. Let him assert categorically that not the least bio-social or socio-physiological principle is involved in the phenomenon. But even if he alleges "simplification," in view of a local "profit," he tacitly invokes a principle which, on a little reflection, is seen to involve other than purely mechanical factors—factors which on scrutiny will be seen to resolve themselves into constituents of the dominant socio-physiology of life, what time it will be plain that "atrophy," if it be "simplification" is also retribution. In the words of Emerson, "what we call retribution is the universal necessity by which the whole appears wherever the part appears," and it is because a universal principle, a principle of service, is offended by the idleness of a part that such a part finds itself universally deprived of support. Let the biologist occasionally look at the whole; let him consider that, in Emersonian parlance, the universe is represented in every one of its particles, and his outlook will soon change for a better one.

As soon as any creature, be it a lowly weed, or a human genius, slips back on to a lower evolutionary plane, it begins to lose those privileges which it enjoyed on the higher; and when, after a time, it has to yield its place to a better co-operator, competing with it, this astonishes the naturalist who is not at the same time a bio-moralist.

Speaking of what takes place in the waters, it, of course, never occurs to an orthodox biologist that even in the water fundamental duties of co-evolution

have to be fulfilled, if health and progress are to be maintained. He feels so sure that the waters represent nothing but chaos, and a cockpit, that he will usually exultantly point to their case as proving his necrological theory of evolution. Yet is there reciprocity even in the waters, and yet is it true that there, too, such reciprocity plays a most important part in determining the life and the survival of the species. If aquatic animals are not active enough in their production of carbon dioxide gas, for consumption by aquatic plants, the latter cannot in their turn furnish their indispensable supplies of oxygen (much of which remains in a dissolved state in the water) as copiously and efficiently as they otherwise could, to the detriment of life and of evolution. Well may it be that excellence in the furtherance of gaseous reciprocity alone, seeing how important it is, weighs the scales against sluggishness, enabling active organisms to obtain a better standing than sluggish and parasitic ones can attain.

The Trilobites are supposed to stand between the Copepods on the one side and the Brachiopods on the other; and it is instructive to learn how closely the life of the Copepods is regulated in accordance with the division of labour between plant and animal kingdoms. The Copepods in the water respond to light by directive movements, whereby food-supplies, namely, green algae, become available. The movement brings the animals from one part of the water which contains a maximum amount of carbon dioxide to a part where, thanks to the presence and activity of the green algae, the food sought by the Copepods, the water is not fully saturated with carbon dioxide. When the animal encounters carbon-dioxide conditions, which are normally associated with hunger conditions, it takes the hint and phototropes, this showing that tropistic response is ultimately connected with nutrition, and what is more, that evolution and the integration of life are proceeding on principles of mutuality.

Well may it be that the reason why the Copepods

have not also become extinct, like the Trilobites, is that they lived up to the requirements of reciprocity in co-evolution, although, of course, gaseous interchange is but a part of the evolved reciprocity between the kingdoms. It stands to reason that those animals that are actively reciprocal with the plants are likely to make use of, and to develop felicitously, a number of useful muscles and organs, with a corresponding gain of oxidasive power and a corresponding advance in complexity of organisation, in contradistinction to the shirkers, idlers, and parasites, which are not so favourably circumstanced with regard to normal nutritive stimulation, normal biological support and normal biological control.

For the same or similar reasons, almost any kind of activity in animals is better than sluggishness, which latter method of life violates the fundamental mission of the animal as active partner of the (fixed) plant. And we can thus, too, the better understand why it is with "protection" in Nature much the same as with protection amongst men, it leads to abuse, to a blunting of the powers that ultimately make for biological reciprocity, wherefore it must lead to inferiority and decline. The principle that activity is required in the true interests of biological reciprocity (the respective adaptation being superior to that of sluggish creatures) has been misconstrued to mean that Nature is enamoured of Mars. But evidently what she is after is pre-eminently efficiency, such as is most in keeping with her grand system of evolutive reciprocity, and not at all mutual plunder and destruction. It is, therefore, only a partial truth when Prof. Watts tells us that "every time the race has been to the swift, active and strong," whilst, as he thinks, those that trusted to "passive resistance," to "defence and not defiance," have gone under in competition with those which have been prepared to face the risks involved in attack. The true version of the "struggle for existence" is this, that those which trusted to short cuts, including aggression, rather than to serviceability, have gone

under—a very different interpretation from that of the schools.

On a little reflection, it will be seen that it is not so much "defiance" that has rendered victorious races strong and resistant, as the beneficence of the fundamental bio-chemical factors of their existence; this beneficence depending in turn upon the quality of the underlying bio-social and bio-economic factors upon which they have placed their reliance. It is easy to be "defiant" once you are strong. But strength itself owes its origin in the first place to a quality very different from defiance—a quality of a gentler yet more constructive kind. When "defiance" becomes rather pronounced in the organic world, then as a rule pathology due to concomitant abuse of power has always set in, which it is of some importance to remember if at long last there is to be an understanding of evolutional pathology. For it is not strength *per se* that is the desideratum, but rather controlled strength. It is work, humble work in the gaining of a honest livelihood, which has made organisms really strong in the sense of true viability. Hence, too, the law of service is axiomatic as a kind of moral obligation in evolution. And in actual fact organisms do serve each other greatly. How sure is the "professor" in his assertion that there can be nothing but deadly strife between, say, plants inhabiting the same piece of land. But it now emerges that, as a rule, despite some rivalry, the inhabiting plants are held together by a bond composed of various forms of co-operation, and that even new-comers can get permanent footing on the land, provided they are duly useful. As an instance, the herbage of ordinary grass land, which easily succeeds in keeping woody plants at arm's length, is yet usually very tolerant of leguminous plants such as clover, trefoil and vetchling, and this for a very good reason—they act as co-operators, enriching the soil with nitrates, of which it often stands in great need, particularly where manure is scantily supplied.

The Leguminosae, bearing partnering symbiotic

bacteria upon their roots, excel in cross-feeding, in Symbiosis and in general service ; and they are remarkable, as I have often stressed, for their astonishingly high degree of viability. The "struggle for existence" would seem to have few terrors for them, equipped as they are with integrity and serviceability :

> " Integrity thus armless seeks her foes,
> And never needs the target nor the sword."

Prof. Watts has to admit himself that in size and strength the first members of the fishes, reptiles and mammals, though eventually they made great headway, were "doubtless inferior," and that "probably they must have taken long periods to make good their advantage." In other words, they were morally and potentially the strongest, though not physically so.

On orthodox lines, the course of evolution has indeed been paradoxical; for great strength has evidently often arisen out of apparent weakness from non-aggressive rather than from those "defiant" qualities to which our biologists are so fond of ascribing success. The "defiers" had to give way. Those who were potentially the strongest lived for very protracted periods in comparative humility, inconspicuously maturing physiological powers that led to dominance-eventually achieved, as it were, by moral force. They existed for long periods in a "retreat" (a kind of ghetto, one must suppose), and to orthodoxy it appears very "remarkable" that, as Prof. Watts states, they eventually "took the place to which they were entitled in the scheme of life."

"Entitled"?—A word which does not sound at all geological or Darwinian ; but there is a distinct ring of sociology, a suggestion of values, about the word. The case rather recalls that of the early Christians, who were not exactly "defiers," in Prof. Watts's sense, although in a higher spiritual sense, they may perhaps pass as such. They stood for a higher dispensation than the pagans around them, one by which in the end a more reasonable ordering of life became possible, and

inasmuch as this was the case, inasmuch as they strove for higher ultimate ends, they were "entitled" eventually to take their rightful place, a place of dominion. In biological language, on my reading of the facts, success in the end smiled upon those who spurned short cuts—methods of theft, murder and parasitism—even preferring temporary obscurity and subjugation, and who, so far as defiance goes, opposed evil doers, backsliders and those monstrous in conduct—as it is still necessary in more than one walk of life to-day. Evolution is in the main the development of a moral principle. The lower value has to yield place to the higher. It is a case of do well, better, best; and not at all one of merely being aggressive or defiant.

It is not a little instructive in this connection to recall Darwin's remarks on extinction, particularly those in the "Origin," in the chapter "On the Geological Succession of Organic Beings." He tells us that no one can have marvelled more than he did at the extinction of species, and though he expresses himself cautiously, he yet hints clearly that the solution of the mystery may lie in a better understanding of disease and also of what, for want of a better term, I would call bio-sociality, as, indeed, I assert it to do.

Says he: "When many of the inhabitants of any area have become modified and improved, we can understand, on the principle of competition and from the all-important relations of organism to organism in the struggle for life, that any form which did not become in some degree modified and improved, would be liable to extermination."

We have seen that the principle of competition is but supplementary to the more fundamental and all-important principle of co-operation, which first of all supplies the wherewithal of successful modification, whilst providing at the same time the necessary biological justification for, and legitimacy of, persistent survival. If biologists were to take the trouble to scrutinise the "all-important relations of organism to organism," stressed by Darwin, instead of allowing the

truth to be slurred over by the vague, metaphorical, misleading, and unscientific term "struggle for existence" (which saves them clear thinking and scrutiny on matters which they are loth to introduce into biology, so that they are in reality hiding behind a shield of ignorance) they would find that these are chiefly bio-social and bio-moral in character, and, what is more, that it is precisely upon the legitimacy of such relations that health and progressive evolution depend—a different interpretation from that in vogue hitherto. We can thus no longer escape the indispensable conclusion that some degree of decency of behaviour is demanded from every creature if it is to continue in participation of the benefits afforded by organic civilisation. The lesson of evolution, the essence of the biological modus vivendi, on the same reasoning, is this—that you must play the game—a very interesting conclusion to reach, and one well worth pondering. Similar comment applies to other statements of Darwin. He says, for instance, that to feel no surprise at the rarity of a species and yet to marvel greatly when the species ceases to exist, is much the same as to admit that sickness in the individual should be the forerunner of death—to feel no surprise at sickness, but on the death of the sick man, to wonder and to suspect that he died by some deed of violence. All of which is very much to the point, if only the full logic of the argument had been recognised. We do, indeed, signally fail to appreciate pathological processes, both in extent and in significance, and, sad to record, Darwin's "Natural Selection" has not made their comprehension easier, but, on the contrary, infinitely more difficult. From the moment that, in Samuel Butler's words, Natural Selection was "discharged into the waters of the evolutionary controversy, like the secretions of a cuttle-fish," the outlook for health, physical and moral, became decidedly worse, to the detriment of civilisation. Darwin was a great worker, a great stimulator, a great discoverer, and even a great adum-

brator; yet he failed to explain evolution—a failure for which we can scarcely blame him, seeing that his errors were largely inherent in the mental outlook of his time. A theory of "grab-all," moreover, suggested itself to his contemporaries rather than one of "spare-all." But, as I have often shown, by promiscuous grabbing much "illth" and much filth is usually introduced into the system, whilst at the same time, by way of wrongful substitution, many valuable elements are discarded, the soil thus being prepared for disease and degeneration. There are a few modern writers, such as Morley Roberts, Woods Hutchinson, and Havelock Ellis, who would seem to agree with me that in applying what we know concerning society to the body processes we may further scientific knowledge. As Mr. Havelock Ellis wrote in the "Nation," 20.11.20, in reviewing Mr. Roberts's book "Warfare in the Human Body": "The idea (of the aforesaid analogy) is, of course, not original. It is found, for instance, in Wood Hutchinson, whose explanation of cancer was along the same path as Mr. Roberts's, but it is doubtless just now "in the air," and we may see it, for instance, in the newly published work, "Symbiosis: A Socio-physiological Study of Evolution" by Mr. Reinheimer, a scientific writer who resembles Mr. Roberts in freedom from professional prepossessions, although he has behind him a medical education, but, unlike Mr. Roberts, emphasizes the complicated reciprocity of symbiosis rather than its latent hostility."

Prof. Watts tells us of races falling behind in the race of life when degeneration or overgrowth in size, attended by neglect of the means of defence, has occurred. But if once we admit the principle of neglect—a psychological principle surely—should we not deal comprehensively with this factor, and make allowance for every form of it? Should we not state clearly that evolution depends very largely upon psychological factors? Should we not include neglectfulness in reciprocity of service—biological service, which is the measure of an organism's worth—which, by way of

reaction leads to retrogressive, and often acromegalic, determination of the organism, in accordance with the saying " as you sow, so shall ye also reap " ?

Neither Prof. Watts, nor my critic G.P.B., has a better theory of degeneration and of overgrowth than that which attributes them to neglectfulness in reciprocity. Both are content with superficial reasoning, invoking psychological factors in a haphazard sort of way when it helps to fill the gaps left by their mechanical theory of evolution. To both of them degeneration and monstrosity appear as chapters of accident, as does disease generally to superficial thinkers. Degeneration occurs, Prof. Watts suggests, when " an area has been for so long sheltered from the wider and more general course of evolution that it has fallen seriously behindhand in the race."

This is a kind of " backwoodsmen " theory, which in a general way has something to commend it, except that it propagates the Darwinian error of crediting some outside agency with the discharge of function which can only be legitimately ascribed to living beings themselves. It is making the " area " responsible for the neglect, instead of the organism. Just as some " backwoodsmen " are too prone to put their own narrow self-interests above those of the community as a whole, growing fat, opulent and monstrous, but inefficient, so also a selfish organism becomes pampered and diseased, liable to be ruled by, instead of ruling, its area. This is the way to retrogression. Others however have chosen better. The maritime " area," not being permanently satisfactory, for instance, some species developed initiative enough to climb out of it upon the land, no doubt only after long and strenuous efforts, involving psychological factors, as it also, no doubt, involved bio-social factors. Plants were, doubtless, the first to make the transition from the aquatic to the terrestrial " area." Aided by them, animals followed. May we not assume that there was some choice in the matter, concomitantly with a striving for betterment ? Not until the plant had left its primitive ocean home did any blossoms

appear amongst the greenery; but we may presume that in the success of the plant the partnering animals had at least some share, too, which is only saying in other words that evolution was largely by Symbiosis.

Even if a critic tells us that the quest for a new "area" (if he admit this much) usually resolves itself into a quest for food, we shall not allow this to be construed as proving a mechanical, deterministic theory of evolution; for, in Samuel Butler's words, "food is very thoughtful, from thought it came and back to thought it shall also return." At any rate, improvement of food is due to Symbiosis, and it is always the quest after the more refined food that may be said to have helped the organism onward in evolution, whilst the search for coarse food has led it downwards. The less reliant on Symbiosis an organism is, the more it is determined by the environment, and the more amorphous it becomes in structure. Many races of flowering plants, and even many of the mammalia, amongst animals, flouting high degrees of reciprocity, as obtainable on the land, have chosen to revert to the water, *e.g.*, the duckweeds in the vegetable world, and the whales and porpoises in the animal world, and all of these bear the brand of degeneracy. The Cetacea, for instance, are physiologically inferior to their ancestors, although my critic may never have heard of this. Moreover they show many striking stigmata of degeneration, as was pointed out in my book on "Symbiosis." The new "area," to which, of course, they had to adapt themselves, was only secondarily responsible for degeneration and for overgrowth; the habits, the behaviour, being primarily responsible for this. The Cetacea, one might say, had the choice of being peers amongst mammals, or monsters amongst fishes, and, led by their appetites, they chose the latter, jettisoning their birthright of normality for the doubtful compensation of monstrosity (albeit not entirely abandoning the mammlian principle of life).

There is nothing preposterous in this view of behaviour, which after all bears a certain correspond-

ence with our own behaviour and is followed by the same effects. *Per contra* it would seem to be the height of preposterousness to attribute evolution to a mechanical process, excluding *ex hypothesi* the striving for betterment, while all the time speaking of the part played by "neglect" and "sacrifice" made by organisms towards the attainment of ultimate (high) ends. Yet such an equivocal attitude is the one most common amongst professors of biology, who are evidently endeavouring to sit on two stools at one and the same time, whilst rigorously and vociferously denouncing those who are far more logical and consistent than themselves. Thus, in a reference to the symbiotic traffic between plants and seed-distributing birds, Prof. F. O. Bower, the botanist, who, it is true, is only mildly Darwinian, tells us that the price paid by the plant in surrendering the pulp of its fruits to the helpful birds is not too high, since the "sacrifice" helps to attain the "ultimate" ends of the plant. Such sacrificial purpose forms, indeed, according to him, the "biological rationale" of all pulpy fruits. There is something so exceedingly "reasonable" in this "biological rationale," that we cannot but conclude that "reason" amongst organisms, however slow in its assertion, however different in degree, very closely approximates to the human, at any rate so far as the important matters which count for most in evolution are concerned.

In his "Plants and Man," Prof. Bower states: "But if there is thus a sacrifice of material gained tediously by photo-synthesis, why does this happen? Would it not be better for the plant to conserve it all as dry fruits do; or best of all to store it in the seeds for the use of their embryos on germination? It is in the ultimate interest of the young plants that the sacrifice should be made. The loss is biologically justified by interaction with living mobile animals, especially birds. Attracted by the colour, scent and flavour of the juicy fruits, they eat the pulp and the seeds together, and the latter, passing through the alimentary tract

alive, are deposited at a distance. The point gained is the distribution of the progeny."

This is, of course, but one illustration of the universal rule of evolutionary progress by reciprocity or by Symbiosis. Deep down in the constitution of every creature, except the most degenerate, we must presume there resides a profound instinct for service, for corresponding sacrifice and restraint, of a similar nature to that bio-moral imperative which makes for sacrifice towards the ultimate attainment of higher ends in evolution. The existence of such instincts must indeed be held to be one of the basic facts of life, one upon which we must primarily rely in formulating our theory of evolution, if it is to be well grounded in Nature. Wrong therefore it is, I hold, to start, as does Darwinism, from the point where organisms get involved in deadly struggles, even though the care of offspring be the cause. Far more fundamental it is that through the very necessity of having to provide for offspring, organisms become involved in a web of life, implying service, mutuality, altruism, and economic and moral endeavour. I am ready to admit that organisms may be but little conscious of the moral imperative, or it may be true that they evince decent instincts from ruinous necessity rather than from obedience to timely wisdom. Nevertheless it is a fact that under the perennial compulsion of having to make due provision for offspring, and of having to maintain integration, organisation and status, organisms thus could not help having some considerable degree of "nobility" implanted in them as part and parcel of what may be called their normal equipment. We must not shirk this indispensable conclusion because of the difficulty of having to account for the presence of so many "dishonest," or "felonious" species. For these are of the throng of "failing" species. It is merely that the nemesis befalling the baser kind of species has not as yet been recognised, wherefore, it is, too, as I would again emphasize, that disease and degeneration have not yet been comprehended in their true inward-

ness. You cannot be an organism unless you conform to the conditions of existence. And one condition is this : that you cannot go as you please, that you must be instinctively restrained.

I would strongly insist that the question of the fundamental instincts of organisms must rank before that of the pressure of population—involving as it does the Darwinian struggle. Pressure of population notwithstanding, exaltation of type has been making steady headway, which it could only have done if there was a sufficiency of the better instincts implanted in life. Necessity is indeed the great taskmaster of life. But the necessity to serve and to co-operate takes precedence of that of deadly competition with others, which arises only secondarily, and, more often than not, as a result of abnormality of behaviour. Even from considerations of the physical constitution of things one is led to suppose that all bodies are under definite cosmic restraints, that the presence of units, particles, systems, organisms and species is undesirable in our scheme of things, unless they are austerely constituted, *i.e.*, only under certain well-defined economic conditions. Obedience to the constitutional laws of the universe is a pre-requisite of success. It is the purposelessness of things and of species that involves elimination and conflict.

Prof. Watts refers us to "the wider and more general course of evolution." But what is it that constitutes that course ? Essentially, I should say, it is constituted by a symbiotic scheme of things, dependent upon a complex reciprocity between mutually complemental organisms, *i.e.*, principally and most fundamentally, between plants and animals. Only by such complex reciprocity and corresponding division of labour could the bio-chemical power, necessary for progressive evolution, have been engendered. Such reciprocity is more marked upon the land than in the water. Terrestrial conditions of life are more favourable than aquatic to the advance of Symbiosis, owing to the greater security of life and the better or ampler

opportunities for mutuality. Hence, too, it is upon the land that we find the most developed, the most advanced, and the most intelligent animals.

The idea, here affirmed, of a "wider and more general course of evolution" rather upholds my theory in a general way against criticism, inasmuch as it, too, rests on the discernment of a difference between several courses showing divergence rather than correspondence. Prof. Watts, in order to justify his generalisation, in view of exceptions, urges geographical isolation; whereas I more particularly urge physiological isolation. I contend that universally, no matter in what area they be, organisms that flout Symbiosis, being sluggish, predatory and parasitic, *ipso facto* divorce themselves from participation in the union of strenuous and progressive life, and are apt to be eliminated or to arrive at blind alleys of evolution.

Side-issues, such as the occasional protracted survivals of bizarre creatures, in the eddies of the stream of evolution, should thus not be pedantically quoted to my detriment when I have to communicate important generalisations concerning the method of evolution. Darwin told us long ago that no fixed law seems to determine the length of time during which any single species or any single genus endures, and that the extinction of a whole group of species is generally a slower process than their production. Do not let us have the presumption, he argued, to imagine that we understand all the many complex contingencies on which the existence of each species depends. None the less some broad generalisations, little or not at all apprehended by Darwin, with regard to survival, now begin to disengage themselves; and during the last thirty years many statements, taken as gospel truth in Darwinism, have come in for serious questioning.

If my critic in "Nature" could tell us that amongst sharks extinction had never occurred, then he might conceivably have an argument against my theory. But is he in a position to claim such an exemption for this highly predatory tribe? Not by any means;

and the principle that predacity leads to extinction rather than to survival, not to say progress, must be conceded here, too. We might take as an example amongst sharks the genus *Carcharodon*, which is here of special interest, since the single still existing species is the most formidable of all sharks, whilst truly formidable also were those which preceded it in Tertiary times. Despite their formidableness, their power of aggression and defiance, these, according to Darwin, ideal beings have become extinct, and the existing species, *Carcharodon rondeletii*, which occurs in nearly all tropical and sub-tropical seas, seems to be verging towards extinction. It is known to attain to a length of 40 feet, and there have been species, now extinct, which have been still more gigantic in bulk. We now begin to realise that the attainment of gigantism is tantamount to disease. My critic G.P.B. shares the common prejudice that in the sea organisms can only exist by devouring others. Predacity is there thought to be the only rule, as though in the sea more than on land animal life could exist without the plants; as though there were not Symbiosis also in the sea, where it is just as indispensable as on the land. The presence of vitamins in cod liver oil has stimulated the inquiry into the origin of the vitamins in the sea; and we have since learnt that we must revise our ideas regarding the food of fish in many ways. Instead of regarding the cod as a ravenous consumer of the smaller fry of the ocean, we must now place him in the status of a plain sea-grazer, i.e., the cod obtains his vitamins chiefly direct from the plant, their true source. As with cod, so it is with other fishes. In an article on the "Methuselah of the Mississippi" in "Scientific Monthly," Jan., 1923, Dr. R. E. Coker tells us of a fish in the Mississipi "more ancient with reference to other kinds of fish than was Methuselah with reference to his youngest grandchild of the 9th generation. It is the paddlefish, single representative of an order of shark-mouthed fishes, which is believed to date back to a very early period in the evolution of the finny

tribes of fresh waters and the sea. We are told: "The paddlefish is remarkable, not only for its bizarre appearance, its primitive structure, and its isolation from any relatives, *but also for its feeding habits*. One might suppose that a species which had survived for such a long period would be found to be peculiarly fitted to take care of itself in conflict with associated species, that, like the sharks of the sea and the garpikes and bowfin of fresh waters, it would be extremely predaceous, if not actually pugnacious; but like Methuselah in his last years—or last centuries, perhaps—the paddlefish is extremely peaceful in disposition and addicted to a *diet of the simplest character*. It may have attained its second childhood, or it may never have left its first childhood, *as regards the matter of feeding*. The young of all of our common fishes, having tiny mouths, must feed upon the smallest food particles. They are practically all, therefore, "plankton feeders" in early infancy; that is to say, they consume the *minute floating plants* and animals or organic materials which comprise what is called a plankton. As a general rule plankton is to infantile fish what the bottle is to infantile man. Whether or not Methuselah found it necessary to revert to the bottle after attaining an age of seven or eight hundred years, we find the paddlefish of all sizes and ages subsisting upon the sort of food which a black bass would be ashamed to be caught eating at an age of six or seven months." (Italics mine.)

Let my critic G.P.B. revise his ideas about feeding habits in the waters. We have here physiological isolation of a desirable kind, of the kind, namely, which avoids "over-specialisation." Evidently again it is precisely the comparative innocence of feeding habits which is answerable for such avoidance. And it is universally such physiological wisdom which has length of days in her hands. The wonderful retention of what is here referred to as an infantile habit with its good results speaks volumes for the view that the avoidance of "over-specialisation" depends upon the

avoidance of predatory feeding. As was shown in my "Symbiosis," the "over-specialised" are very generally the prematurely aged types, those that became divorced from Symbiosis through predacious feeding habits. The apes, whose ancestors undoubtedly were more predacious than those of man, have lost some of the youthful features which the human being retains into adult life.

They have gone off, as it were, into some "specialisation" of their own, away from the youthful generalised type which possibly was that of a common ancestor. The remarkable claim has been made that the earliest men were in a sense simian Peter Pans—apes that had not grown up. Promiscuous feeding is certainly not the way to retain permanent youth and integrity, be it on land or in the water. Fishes are by no means so universally carnivorous as my critic, in his Darwinian zeal, would have us believe, and the true wonders of survival are everywhere furnished by vegetarian feeders rather than by carnivorous, which is in keeping with my theory.

The late Prof. Herdman found that in spring he chiefly encountered phyto—(plant) plankton, composed chiefly of diatoms. The flora of the sea is known to form successive layers of "meadows" in the deep.

Contrary to my critic G.P.B's considered opinion, there are fish that are content to be vegetarians, and, no doubt, on closer study, many more such will be discovered. Thus the long food-canal of the Mediterranean Bogue, or Box, is said never to contain anything but fragments of seaweed and seagrass. According to Prof. Arthur Thomson, also the Rudd of our British streams might be called a vegetarian, though "not a bigoted one." He thinks that many fishes which eat water-plants and seaweeds like a good deal of fleshy relish in addition. There may be some considerable bias in this remark, dictated by our own omnivorous habits, and it remains to be seen what the findings will be of another generation of zoologists who have emancipated themselves from flesh-eating customs. I have often stated that once the majority of the population

acclaim vegetarianism, the professors will prove its superiority up to the hilt. Obscurantism to-day reigns supreme in biology. Indolence on the part of the masses and false thinking on the part of the classes is its faithful ally.

Quite certain it is that those fishes which have remained principally vegetarian get their important salts, such as those of iodine, calcium, iron, etc., etc., which supply strength and endurance, at first hand, a very important matter, indeed, particularly so as supplies not thus obtained lack the control of Symbiogenesis—of the directing principle, emanating from the activity of symbiotic systems—wherefore they tend to foster that irregular growth which ends in monstrosity. In any case, enough has been said to justify a picture of aquatic life different from that contemplated by my critic, G.P.B. Though there be indisputably a great deal of carnivorism in the sea, I must again insist that it is largely for this very reason that evolution there is backward—lack of reciprocity and of possibilities of elaborating mutuality being a generally hampering circumstance.

Our remote ancestors did well to get out of the water. Doubtless they felt an urge for something higher than the life attainable under aquatic circumstances. Well may it be that, as leading psychologists are now inclined to think, the evolution of the organic world may properly be conceived as primarily and essentially the differentiation of instinctive tendencies from some primordial capacity to strive, to go forward.

There is an "inclined plane," declares Prof. Thomson, leading to fishes which will eat anything and everything. "At the lowest level are the offshore fishes that depend mainly on what may be called sea-dust—the organic debris or detritus washed out from the seaweed zone." He would separate off from the carnivorous fishes those that feed on the minute and often microscopic organisms (the plankton) in the open water of sea and lake. "For this represents a different regime and the plankton includes minute plants as well as

minute animals. These plankton eaters are usually very palatable, such as herring and mackerel, sardine and sprat. (The same has been said of the carp, a notorious "food-fish," which is chiefly vegetarian, and justly famous for its longevity, sometimes attaining to 200 years).

All these are types which get their indispensable supplies of organic salts direct from the source, duly matured and endowed, and in ideal proportion. By no second-hand method can this end be so well achieved. Evolution is also a bio-chemical matter, and if something is to occur, say, on rung six of the ladder to fit the organism for, say, rung nine, the adaptation must still have been one to incline the organism, bio-chemically speaking, for co-evolution between animal and plant. In fact, the higher the status, the more delicately and all-importantly will the organism have to depend on the salts furnished and the oxygen disengaged by the plant. An adaptation, as I have often stated, in order to be really auspicious from an evolutionary point of view, must have persistent reference to the grand symbiotic scheme of life. When the bio-chemical part of evolution is better understood, it will be clearly seen that cross-feeding species enjoy a great advantage in point of progressive adaptation. They are already adapted to a factor which holds out the greatest help on any higher platform to be reached.

We can read almost as much between the lines of Prof. Thomson's description of breathing experiments amongst fishes, especially if we bear in mind what has already been said about the comparatively vegetarian character of the respective types. Says he: "In ninety-nine per cent. of fishes, the oxygen mixed with the water is captured by the blood spread out on the surface of the feathery gills. This is the typical bronchial respiration, and it almost invariably involves remaining in the water. Exposure to dry air is usually followed by rapid death. But this is not invariable, and when we look into exceptional cases, we find that there is some special adjustment for keeping the gills

moist when the fish is out of water. In some fresh water fishes, like carp, there is often a gulping of air at the surface of the aquarium, and this air is passed into the gill chamber to re-aerate the water surrounding the gills. In the so-called Climbing Perch (*Anabas scandens*), which occasionally climbs on trees and rocks, and habitually spends much of its time out of water, there is in connection with one of the gill-arches, a complicated bony labyrinth through which air gulped in by the mouth passes out into the gill-chamber. On the wall of the labyrinth there are many blood-vessels, and there is no doubt that respiration is thus effected."

These, however, are only samples, and, though effective in their way, they have not been crowned with evolutionary success. It was the swim-bladder that led on to the development of the lung. Through an ancient stock, of which the African Fringed-fin Fishes are now the only representatives, the piscine swim-bladder became the amphibian lung—the biggest experiment of all. Let us remember that amphibian tadpoles are as a rule vegetarian, and we may surmise that their order owes its evolutionary success primarily to cross-feeding habits on the part of their ancestors. Let us consider some of the Amphibians.

There is the famous marine Iguana, *Amblyrhynchus Cristatus*, a sea-shore lizard, described as the Vegetarian "Dragon" and "Fasting-Man," since it feeds on seaweeds and can abstain from food for long periods of time. It it so big that it looks for all the world like a prehistoric monster. It proved particularly tame when captured. One of them could not be induced to bite the strangers who sought it for the New York Zoological Park. It is a good swimmer. Those captured by the Harrison Williams Expedition refused all food, and it was found that they could live on salt water and air for over a hundred days. These creatures are found on the Galapagos islands. No other living inhabitant, says a naturalist, seemed so thoroughly a part of its environment as Amblyrhynchus. In its intimacy with lava and surf, it seemed an organic em-

bodiment of the shores of these desert islands. Its swimming capacity is remarkable, and so are its powers of orientation. So also the powerful *Iguana Conolophus Subcristatus* which is a feeder on leaves and flowers, cactus spines and grasshoppers.

Darwin, when he visited the Galapagos Archipelago, was struck by the short-snoutedness exhibited by a tree-climbing vegetarian Amblyrhynchus, which feeds on fruits and berries, and he stated that this feature, important from an evolutionary point of view, depended upon "herbivorous appetites"—as, indeed, it does.

In my volume on "Symbiosis" it was shown that reduction of the snout region was one of the great essentials in that development which led to man. But it was not enough that the snout receded. Greater efficiency was attained by a creature which at the same time emancipated the forelimbs, became erect, and concomitantly developed great capacity of brain. Such development could not have been possible without the constant symbiotic assistance of the plant; and none but symbiotic cross-feeders ever had a chance of reaching such a stage. Orthodox biology has nothing but guesswork to offer with regard to the physiological and bio-economic groundwork necessary for the evolution of the brain, as may be gathered from the following citation from Prof. Watts: "Perhaps the most wonderful result disclosed by a study of the later part of the geological record is the steady and unbroken evolution of brain from the earliest vertebrate animals to the present. The exceeding slowness of the process in its early stages is not less wonderful than its acceleration during the latest stages of geological history. The disappearance of so many orders of reptiles at the end of the Mesozoic Period, at the close of a long and most promising chain of evolution, indicates that there was *some inherent weakness* underlying the line of evolution entered upon by them, which proceeded so far and favourably that it was impossible to retrace the path. This may well have been connected with the substance

or construction of brain and nerve. If so, this side of evolution has to be seriously reckoned with, and it may be that the fundamental weakness of physical as opposed to intellectual evolution brought this flourishing and well-developed group to its end." (Italics mine).

If biologists had in a spirit of becoming humility given some attention to nutrition and to economics, instead of spurning them and substituting for theological obscurantism biological obscurantism, they would not now have to speculate in such uncertain fashion concerning the most important developments in evolution, and to guess vaguely with regard to some "fundamental weakness" in the composition of certain types, destining them to relative inferiority. Fundamental weakness arises in the first place, as does disease, from bio-economically retrograde behaviour—things eternally refusing to be mismanaged long. The fact alone of the arrival of a bio-economically more efficient race of beings means a new dispensation, and it means that support is correspondingly withdrawn by previous partners who now find themselves better served in co-operation with others. The superior co-operators have "dug themselves in" by better service, have rendered themselves more indispensable to the rest of the strenuous community, and, as a result, it is only the inferior pabulum that remains for the sluggards and backsliders. That alone is tantamount to debility and, eventually to disease. There can be neither health nor successful evolution in the absence of a controlled, i.e., symbiotic food supply. The table is not spread for the idle, the improvident, as it is for the superior, or skilled workers, for the better providers, as the facts bear out in hundreds of ways. To that extent, indeed, competition is an important principle of evolution—its virtue is to secure the first place for the best co-operators. We have had the assurance from Prof. Watts that geological time bears an essential likeness to our own time. Let there be no doubt about it that what was sought to be eliminated in one way or another in ancient times was much

the same element as to-day, namely, the useless, or relatively less useful. We may assume that pressure against wastrels is as implicit in the universe as is the urge that makes for the development of the brain.

Modern times are marked by economic endeavour in all possible directions, and, if we are to believe with Prof. Watts in the "modernity" of geological, time we shall not omit the then presence of a more or less purposeful striving for a better and more economical ordering of things, without which, of course, progressive evolution would scarcely have taken place. Let us take an example of pressure against biological wastrels from modern times. On Dec. 12.24, we heard from the "Times" of a new dispensation with regard to "Weed-Infested Land." The principle was laid down that people ought to be impressed with the fact that ownership of land had its responsibilities as well as its privileges, and that men were not entitled to live away from the land, as most of the owners did, without caring what happened to it. Some parties were summoned at the Epsom Police Court for not complying with notices to destroy weeds on their land at Bookham, and fines were imposed upon them. The prosecutor took exception at a magistrate's previous remark that the respective Acts did not apply to building land, but held that they applied to all land, whether agricultural, or any other.

We live in a web of life, which implies duties and responsibilities, and in the fight against those wastrels who would frustrate our best endeavours we have a right to invoke the co-operation of all "hands," if need be of policemen and of overseers, and we know now that such institutions as police, soldiery, body-guards, etc., are not something new to nature. Re-action against evil is universal, and it was of old as it is to-day, namely, the better is the enemy of the good. What happens amongst us in relation to weeds has happened before many times in the world of life and is as much "biological" as what happened millions of years ago in relation to reptiles.

Investigation has shown that in the case of weed-infested land, as compared with perfectly clean land, the yield of oats was reduced from 76 bushels to 25 bushels per acre; of potatoes from 176 cwt. to 90 cwt. per acre; and mangolds from 37 tons to 16¼ tons per acre. It did not require a very large area of land with weeds to infest surrounding land. Hence concerted action has to be taken against weeds. If *homo sapiens* did not take responsible action, he could not survive. And where then would be the flower of evolution, the human brain? Nature seems to have lavished all her resources on the engendering of this fine instrument, as though she had always prepared for this great consummation. Can we believe that she at any time relaxed her pressure against those elements which would have flouted her great purpose? When she needs space for her highest products she will allow neither weeds nor reptiles to interfere, and they have to go, inasmuch as they are prejudicial to the better type.

Predatory creatures and sluggards, therefore, exist precariously, on sufferance, as it were. In the event of any general advance (with which they have increasing difficulty to keep pace) they may be doomed. It is good to be strong and to know how to protect oneself, but unless some fundamental wisdom is coupled with the strength, this may not prove a blessing in the end, but brute strength may defeat its own ends.

Do not let anyone claim that I have given only an isolated example of the natural elimination of the predatory and the wastrels, but let us consider further evidence from another quotation from the "Times," 6/11/24: "The beauty of nature in England is largely of man's making, and we should lose much of what we love best if nature succeeded in emancipating herself. (If there were lacking the control, I should say, appropriate to the present phase of organic civilisation, which must importantly include man). We have lost the great fens, the bustard-haunted ranges round Stonehenge before the plough and the hut-camp came, and

deer forests of many a well-fenced shire. But we have gained something too—the sharpness of Cumbrian mountains, stripped of birch and oak-scrub, the colour of June hay fields and August wheat, league on league of April fruit blossom, and the strong song of the gentler birds . . . When we killed or banished many of our larger and wilder birds, at least we multiplied those which delight in intensive cultivation. A pair of ravens or peregrines need a square mile of territory for a hunting ground, but twenty linnets will nest in one hedge; and where we have lost the kite, or even the sparrow-hawk too, we have at least gained in blackbirds and song thrushes." This is merely an illustration from modern times showing how the monsters of size and iniquity have always had to make way for the smaller but more legitimately living creatures, be it from economic, biological, or physiological necessity.

There is here mention of compensation. I am strongly in favour of thus viewing all biological developments in the light of compensation, which, were it duly done, would not leave us long in doubt about the inferiority of the carnivorous principle, as I have often shown.

Benefit is the end of nature. But for every benefit obtained a toll is levied. If the compensation fails to be forthcoming, disease makes its appearance. We are made for work and service, and it is ill with us if we fail to work. Man's "premier industry" is agriculture, and the services which he renders to the plant through this and other affiliated industries go a long way to constitute man the most ideal contributor, the most ideal compensator in the world of life, wherefore he is entitled to the highest status and to the position he now holds as the arbiter of all organic life. It is man's great prerogative to be the most ideal, *i.e.*, the hard-working and conscious partner of his own most ideal biological helper, the plant. The agricultural path is also that of the highest efficiency so far as muscular development, power of synthesis and of brain generally are concerned.

It is not until we come to the end of Prof. Watts's paper that we get a slight adumbration of the really important, the symbiotic and co-evolutive, factor. Consideration of the evolution of the human brain has forced on the contemplation of some of the most fundamental needs of man, and this, owing to the happy inspiration of a single biologist, has led to a reference to the possible share that the vegetable world may have had in the evolution of the animal. Under-estimated as this factor has been all along by orthodox biologists, yet even from a mere surmise concerning its importance we may glean the fact that Symbiosis must have been the all-important factor in evolution. We are told: "To pick out a single instance, probably few things in the whole story of life have been more fruitful in effect than the appearance of the grasses in late Eocene times, followed by their rapid evolution and spread in the Oligocene and under the direction of the critical events of the Miocene Period. Starkie Gardiner in an admirable paper first directed attention to the vital importance to the animal evolution of the world in general, and to the welfare of man in particular of this step forward. It was followed by great changes in the insect world, by the rapid production of herbivorous mammals endowed with speed, great migratory powers, special dental and other anatomical adjustments to the new foods, and the institution in their herds of a discipline, subordination and leadership which are almost tribal."

Here we have a picture of the world which, in its "pleasantness" and, one might almost say, gentleness, surely entitles one to take a generous view of Nature, one indeed almost approximating to the older theological accounts of a kindly but still somewhat exacting Providence. When the occasion for the manna, *i.e.*, the "new foods," had arisen, Nature providentially provided the new alimentation that was wanted. What is more, the most wonderful correlated improvements followed from that one favourable providential accident. There was an appearance of grasses, miraculously, as supposed,

the otherwise mechanical process of evolution not being slow to take advantage of the fact. Even those who dwell in darkness sometimes behold a light. Starkie Gardiner, it is to be hoped, will receive a monument for this discovery. May we not confidently believe that the same principle that is involved in the inter-action between the world of cereals and that of man to-day was in operation even at the earlier periods of geological time when the grasses were evolved by symbiotic synthesis, much in the same way as they subsequently helped to evolve higher races of animals and men ? In succeeding chapters it will be seen that this is the fact, and that Symbiosis is a permanent indispensable.

Chapter II.

Darwin's False Premises.

The theory of "Natural Selection" is, in the words of Dr. Lancelot T. Hogben, ("Discovery," June 1924), and as I have shown for years, "based on premises which cannot to-day be considered as having any foundation in fact."

This was evidently the view also of Bateson, who told us of a letter which Huxley sent to Kingsley in 1863, containing the following significant passage: "From the first time I wrote about Darwin's Book in the 'Times' . . . until now, it has been obvious to me that this is the weak point in Darwin's doctrine. He has shown that selective breeding is a *vera causa* for morphological species; but he has not yet shown it a *vera causa* for physiological species. But I entertain little doubt that a carefully devised system of experimentation would produce physiological species by selection, only the feat has not been performed yet."

Bateson's comment, however, demolishes once and for all such vain hopes, and Bateson was in a position to speak with authority on the subject. "Nothing," he says, "that has happened since at all mitigates the seriousness of this criticism. The words quoted above may, indeed, be used to-day with an even stronger emphasis, although I doubt whether many of those best acquainted with modern genetics are so sanguine as Huxley that by the most carefully devised system of experimentation are we in the least likely to produce physiological species by selection. Rather have we come to suspect that no amount of selection or accumulation of such variations as we commonly see contemporaneously occurring can ever culminate in the production of that 'complete physiological divergence' to which the term species is critically applicable."

And he adds significantly: "With entire candour Huxley reiterated that if this were the necessary and inevitable result of all experiments, the Darwinian hypothesis would be "shattered." Nothing was to be gained "by glozing that difficulty."

The bottom is thus knocked out of the "selection" argument, which never had much of a leg to stand on. "Selection" has failed to make good, and the attempt to formulate a theory of evolution on Darwinian lines has utterly broken down. A "morphological" species—a species in form merely and not in spirit—is more often than not a pathological species, *i.e.*, it is merely superficial, obtained by the break-up, the exploitation of, a duly evolved natural species which constitutes a "physiological" species. It is a species deprived of vital factors, of vital strength. It is easier on the whole to obtain new productions by abstraction than by additive synthesis, just as it is easier in many ways for the organism to adapt itself to retrogression than to progress. Broad is the road that leadeth to destruction.

Progressive evolution is the result of the summation of powers in co-operation, such as in symbiotic integration, which, as I have shown, involves moral factors. The new organism, in order to become a "physiological" species, must, as it were, be "spiritually" integrated—integrated, that is, also in a bio-social, bio-moral, and bio-economic sense . . . Those who do the thing, *i.e.*, co-operate in due degree, shall have the power—that is the law of Nature in the evolving of species.

Physiological species do not emanate from laboratories. It is a pity that biologists are so thoroughly wedded to laboratory methods as to have no eye for the method of Nature; although Stahl, a botanist, showed how these methods could be reproduced in the laboratory, as when he came very near making a new species of lichen by the artificial union of an alga with a fungus which had had some previous training in partnership. Darwin cherished domestication as the most fertile field for the study of evolution. It offers indeed a good illustration of how evolution could *not* have been produced.

Fully as unsatisfactory as the genetic are the philosophic premises of Darwinism. "Nature acts solely by and for the good of each being." So runs a fundamental and significant tenet of Darwinism, which has not received the scrutiny it deserves, but which has, on the contrary, been thoughtlessly swallowed as gospel. On this tenet the "disciples" of Darwin have founded the fact of "progress." As Sir E. Ray Lankester stated in "Nature," 12/8/20, "as natural selection works by and for the good of each being, all corporeal and mental endowment will tend to perfection. Darwin was a convinced optimist."

Darwin needed indeed to be an optimist; for progress is a *non-sequitur* on his theory. The "good" of each being, in Darwin's tenet, includes any conceivable advantage, even the merely expedient, irrespective of the common good of all beings, so long as the change, or the condition, is at least compatible with the merest survival of species. We are to understand that Nature is merely after "adaptation." The word "solely" is to warn us against any moral connotation of her action. Nature merely ("solely") seeks to aid this mechanical process, sublimely disinterested in moral issues. The real moral good of the being is not asserted in the Darwinian tenet. It is, on the contrary, denied. Nor is it even that by "progress" Darwinists necessarily mean augmentation of corporeal and mental endowments; but loss of such endowment, as in parasites, for instance, is also to be included in the category of "progress." Degeneration is so included, ostensibly on the plea that it represents "useful" simplification, which, were it true, would make all high organisation appear haphazard and almost perfunctory. Nothing could be more dismal and more lamentable from the point of view of the public good than the attitude of orthodox biologists with regard to degeneration. Great and profound lessons of health and morality are here to be gleaned, instead of which biologists invert the process, and rebuke us for thinking that evolution has on the

whole been progresssive, telling us that for every single case of advance they usually discover ten of degeneration.

"These things are," they argue, "therefore they must be." If they discover ten cases of degeneration for one of advance, it must needs be, they allege, that degeneration is the normal thing and advance the abnormal. Conceivably they have not paid sufficient attention to the normal method of evolution. I aver that they have not, and that the whole of biology, including the science of medicine, languishes because of that defect.

Darwin told us that, in speaking of "improvement," he is entering upon a very "obscure" and "intricate" subject; for "naturalists have not defined to each other's satisfaction what is meant by advance in organisation." This handicap still exists, and it is so serious, in my opinion, as to make the teaching of evolution as now understood scarcely worth having. Biology is to-day as utterly discomfited as it was in the days of Darwin. It is the most inchoate of all the sciences. It has not been able in the slightest degree to get over the initial difficulties so acutely felt by Darwin. "What advantage," Darwin asks, "*as far as we can see*, would it be to an infusorian animalcule—to an intestinal worm —or even to an earthworm to be highly organised?" (Italics mine). This shows the utter lack of standards of value in Darwinism, although, as the italicised portion indicates, Darwin at least felt scruples or doubts with regard to status, in his interpretation of "usefulness." Evidently he anticipated that one day we should see further with regard to status and "usefulness" than he could, as, indeed, I strongly insist, we shall have to do. For it is one of the wildest of errors to imagine that in Nature the sociologically inferior way could be equally sanctioned with the superior, which is not only contrary to the facts, but, if it were true, would traverse the universality of causation, which is a fundamental assumption of science. Human values are what the "natural

process" has made them. "Nature," too, is responsible for our values. The fact that numerous species live by mere expediency does not invalidate the truth that there is a good and moral pathway of evolution. Parasitism, the supremely self-regarding principle of life, offends against bio-moral principles, and, therefore, is not in the line of progress—a proposition not too difficult to prove. Darwin admitted that the productions of Nature are far "truer" in character than those of man (in the domestication of animals), and that they bear the stamp of far higher "workmanship." He should have asked himself whether perhaps Nature has a specially felicitous method by comparison with the inferior method of man. If it should be that man merely makes use, as an exploiter, of the results of the good method of Nature, then we should above all search to discover the secret of Nature's good method, rather than trifle with superficial analogies.

Now, there can be no doubt that the chief factor answerable for the dire effects of "selection" is this: the one-sided exploitation to which man subjects the creatures, that is to say, strictly speaking, a moral factor. Man's method is *pro tanto* bad. Darwin was alive to this cause, which he did not shrink from admitting, as may be gleaned from his great work on "Variation under Domestication." But he did not see his way to apply this truth that one-sided exploitation is bad, as it should have been applied, and actually does apply, universally. He had already, unfortunately, invented, with the aid of a false analogy, a *deus ex machina*, "Natural Selection," which, since it did everything that was required in the way of "fitting" organisms, allowed him to dispense with moral factors, with a science of behaviour, altogether. The true analogy would have been between good use of organism by organism in Nature, and good use of class by class in human society, evidencing the superiority to bad use in each case.

That "Natural Selection" hung like a millstone round Darwin's neck may be gathered from the way

he was constrained to exculpate criminal habits in nature, as though they really benefitted the species. Speaking of the parasitic habits of the cuckoo, and of similar criminal habits amongst insects, he tells us that he can see no difficulty in natural selection making an occasional habit permanent, if of advantage to the species, and if the insect whose nest and stored food is feloniously appropriated be not thus exterminated. In other words, a little felony does not matter, so long, at least, as it stops short of glaringly defeating its own object—a sophistical teaching.

But the moment it is seen that extinction is but the final retribution of a protracted course of felony, the entire fabric of Darwin's natural selection theory will crumble.

The ill-effects of unilateral exploitation in domestication, to which Darwin was painfully alive, should have warned him against ascribing real good effects to criminal exploitation in Nature. There is no power in heaven or earth stronger than Nemesis, which keeps watch in the universe and lets no offence go unchastised. There is no power which could traverse the universality of causation. No amount of natural selection can alter the retribution to be exacted by Nemesis. Not content with discovering a new deity ("Natural Selection") which Greek mythology had overlooked, Darwinism discovered a new kind of morality—"non-morality." If an organism preys on another without entirely exterminating it, this is "non-moral"—a wonderful discovery indeed! One wonders whether the robber-kings of old were not secretly addicted to the cult of "non-morality."

But mere non-moral disinterestedness, even on the part of a Goddess, is not positive, not efficacious, enough to achieve the result of progressive evolution. That, as we are now beginning to see, requires more; it requires a definite integrative socio-physiological process, involving the combined industries and the constant labour of strenuous organisms. By such austere and co-operative methods alone could the protoplasm be enriched, could truly physiological species be evolved—a feat which the selection we know has never been able to accomplish.

Chapter III.
Adaptation and Environment.

"Do animals and plants grow into conformity with their surroundings because they and their fathers and mothers take pains, or because their uncles and aunts go away? For the survival of the fittest is only the non-survival or going away of the unfittest—in whose direct line the race is not continued, and who are, therefore, only uncles and aunts of the survivors. I can quite understand its being a good thing for any race that its uncles and aunts should go away, but I do not believe the accumulation of lucky accidents could result in an eye, no matter how many uncles and aunts have gone away during how many generations." Samuel Butler.

In "Nature," 5. 6. 25, we read the following statement by Prof. F. Guyer, a distinguished American zoologist: "The fact is that biologists have never as yet hit upon an explanation of the marvellous adaptedness of organisms to their environment which does not put tremendous strain upon our credulity, and when we view it with unprejudiced eye, it seems to me that the theory which would attribute adaptation to the mere accumulation of such chance variations as happen to be favourable is the most incredible of all. Time and again in the past, according to palaeontology, whenever new possibilites for existence occurred, forms of life admirably adapted to those conditions have come to occupy the new habitat. In some way the environment has moulded these new inhabitants to its bounds, and it takes more faith than I personally possess to believe that it has all been done by the negative method of killing off generation after generation, the non-conformists—those in whom the happy accident, or rather the innumerable inter-related series of accidents, has not happened."

This is only one of the many examples of the dissatisfaction now pervading the schools, half a century after Samuel Butler had stated the case against Darwinism, only with much more skill and acumen than professionals are capable of.

It is clear from the palaeontological evidence already considered that all this talk about "adaptation," "adaptedness to environment," and "variations," is illegitimate, since we know too little about "variation," and since we do not at all see clear with regard to "environment." What is the "environment" of an organism? What is not its "environment"?

It is time this "accident" position was dropped, and a beginning made instead with the introduction of clear concepts with regard to "environment." An organism in itself is but a part; Nature is its complement. But let it be understood that there are marvellous opportunities for the organism to extend and to improve its relations to the complement. Zoologists and even Palaeontologists can have no due conception of what the organism itself can do by way of making progressive adjustments to the "environment" so long as they neglect the study of Symbiosis, the chief means by which the great steps in evolution have been accomplished, as I have often shown.

Why for ever talk about the moulding effects of "new habitats," and ignore the share the organism has had in moulding the environment, as though those organisms which have suffered themselves to become too greatly moulded by the environment had not in reality failed to make a proper adaptation?

Modification, like charity, begins at home; and the shaping of the organism for permanent rather than transitory survival requires honest rather than merely expedient adjustments, honest rather than merely expedient ways of life. But have biologists ever been known to sift the grain from the chaff? They are purblind to the fact that only those types which adapted

themselves in accordance with the spirit of the time—a spirit of mutual service in co-evolution—have been able to find the normal pathway of evolutionary progress.

Clearly, the perplexity of modern biology results from the fact that it has spurned a philosophy of value and pinned its faith instead to mere expediency as the "leitmotif" of life. It is their fundamentally wrong attitude too which causes biologists to look askance at Symbiosis, a relation in which the possibilities of a living in conformity with the most enduring and in the long run the most profitable associations with the environment are most ideally provided.

It proved profitable to many plants to have made the wind a useful part of the environment—as pollen-carrier; but more profitable in the end to enlist the specially remunerated services of the animal world, *i.e.*, to shape environment, and thereby evolution itself, in accordance with methods of Symbiosis.

The most "marvellous adaptedness of the organism to its environment," in the sense used by Prof. Guyer in the above quotation—the one with which biologists busy themselves most—does not at all compare in importance with symbiotic adaptation.

The biologist thinks only of the purely physical adjustment, which is but secondary in importance, though it be outwardly the more conspicuous. But he may be, and usually is, dealing, though quite unwittingly, with a case where the organism has failed to mould the environment as it should have done, and has, hence, suffered elimination of some sort, which has either led it to a *cul de sac* (loss of status I consider to be a form of elimination, too), or brought it to extinction.

It is time biologists dropped their pretensions and made a start with the essential distinctions as here indicated. It is time this talk about "adaptedness to environment" and "accumulation of variations" had to give place to larger considerations such as here set forth, and such as are alone germane to so big a subject as evolution.

We must study behaviour on broad lines and in the light of the interdependence of life. For, on a *tout-ensemble* view, it is evident that the environment of the organism is mainly constituted by an evolving, co-evolving, inter-dependent, fraternity of life, entailing a veritable "organic civilisation," in which all manner of offices, high or low, permanent or transitory, have to be occupied, whilst "adaptations" and "variations" have to be shaped accordingly.

Seek first a métier, this is the motto of evolution; and, so long as the vocation of the organism has some value in organic civilisation, entitling the species to some remuneration, and so long as the species can efficiently fill its post, there is a chance of survival. In evolution, as in human society, remuneration is according to service. The higher the service, the greater the remuneration.

According to Darwinism, it is all a matter of competition, and of the "survival of the fittest." But it is questionable whether we have hitherto known the true standards of health and fitness. True health and fitness are results, complex results, or creations. It is by no means enough that the individual is "looking well," or passes as "fit." Physiological bankruptcy is not always apparent on the surface of things. Nor is the test of competition always reliable; for the weaker organism may come out on top in the end because of superiority in other essentials.

In human trade competition, the fittest assuredly are those who are capable of beating their rivals by giving greater satisfaction to customers, *i.e.*, those mainly reliant upon fundamental co-operation. So, in the case of the plant, the way to achieve fitness and survival capacity has been to give the utmost satisfaction to (animal) "customers." The degree to which the plant is able to excel in this line of behaviour borders on the miraculous, unless we take the view that a fundamental Symbiosis is at the base of the marvellous adequacy in animal economy of vegetable-produced substances. If

the plant is duly to accomplish its exalted functions, it cannot afford to be a parasite, but it must remain a producer, a servant, a minister. The plant which competes for a place in the sun, is also a plant which competes for a place of service. As Samuel Butler said : " If we admit that to some considerable extent man is man and master of his fate, we should admit also that all organic forms which are saved at all have been in proportionate degree masters of their fate too ! "

Now with regard to palaeontological evidence concerning evolution by behaviour, as against the idea of merely expedient adjustment to surroundings. This matter was recently broached by Dr. W. P. Pycraft in a paper on " Use and Disuse as Factors in Evolution," read before the Royal Institution, and summarised in the " Illustrated London News," 9.5.25. Here again we meet with dissatisfation with Darwin's theory, although the dissent is expressed very guardedly, so as not " to do harm," and not to give displeasure in certain quarters, one may presume.

We are told at the beginning that : " As matters stand to-day, what we may call the " official view " of such " adjustments " is that they are the outcome of the action of " Natural Selection," which has favoured the survival of individuals which developed, now in one direction, now in another, variations or departures from the type, such as afforded their possessors an advantage over their rivals in the " struggle for existence."

But such a view will no longer work, and Dr. Pycraft has to " modify " it. If it had not been for the wicked Weismann, he lets us understand, our vision of the main evolutionary factors would not now be so obscure as it is.

One implication, of course, is that palaeontological study is calculated to open up vaster vistas of evolutionary thought than are usually vouchsafed to the ordinary zoologist. That is quite true. The question is, nevertheless, have we as yet duly interpreted palaeontological evidence ? As I would interpret it, it is plain that Darwinism is not in the running and is altogether

obsolete. The complete teaching of palaeontology is consonant with common sense rather than with Darwinism. The present state of things again shows that Samuel Butler was entirely justified in declaring that "common sense is not yet formulated in manners of science or philosophy, for only few consider them ; few decisions, therefore, have been arrived at which at all hold final. Science is, like young love, too young to know what conscience, or common sense is."

Let us see how Dr. Pycraft proposes to "modify" Darwinism. His own sojourn in the "Valley of Dry Bones," in which he "lived so long" has imbued him with distrust of "Natural Selection." He has learnt that there are "many" factors in evolution instead of only one, as was hitherto supposed—another way of saying that the employment of a single (spirit) agency, such as Natural Selection will no longer do, since there are new realities, not at all, or imperfectly, accounted for by it, which are now, however, beginning to loom larger and larger on the biological horizon.

Yet Dr. Pycraft wants to retain Natural Selection—still a useful cloak of ignorance, as we shall presently see. He tells us that "all living things must run the gauntlet of "Natural Selection," an exceedingly involved and metaphorical way of saying that all organisms have in one way or another to meet competition, and to accommodate themselves accordingly (whilst omitting the fact that the law of co-operation over-rides that of competition).

Seeing that such factors as competition, pressure of population, and mutual accommodation entail sociological factors, with which the average biologist is unable to deal, he finds it more satisfactory to stick to "Natural Selection" as a convenient cloak of ignorance ; and that is the device to which Dr. Pycraft has recourse. Impressed by the force of the Lamarckian contention that habit is all-important, he would fain modify Darwin's theory by a version of "Lamarckian Darwinism," as I have styled it.

Hence, we get the addendum that in the running of the gauntlet of Natural Selection "each may run after his own fashion."

This, to my thinking, gives the case for Darwinism away. How far, one would ask, may an organism indulge its own whims so far as "gauntlet-running" is concerned? Or how far does Nature compel it instead to conform to what Darwin proclaimed to be the chief law of evolution, the law of conflict? To what extent may the organism cheat "Natural Selection"? Is ten per cent. of gauntlet-running with ninety per cent. of cheating enough, or is ninety per cent. of "gauntlet-running" with ten per cent. of cheating required, or preferable?

Perhaps Samuel Butler clinched the matter when he stated: "The universe, if it does not give an organism short shrift and eat it up at once, will commonly abate some of its claims; it gets tricked out of an additional moiety by the organism; the organism really does pay something by way of changed habits; this results in variation."

Here at any rate we catch a glimpse of the perpetual tug of war purporting mutual accommodation, as between the claims of the individual and those of the larger community, the resulting change meaning variations either for good or for ill, for permanent or merely transitory use, according to the value (in what may be called "organic civilisation") of the organism's activities.

How does Dr. Pycraft get over the difficulties here involved? By the usual trick, probably quite unwittingly performed, of arguing from abnormality, as though it represented the norm of life. He tells us that "a minimun standard of efficiency is exacted from all, and failure means elimination." So that we now know what the "gauntlet-running" amounts to; it is to ensure a modest, very modest, amount of efficiency. Why only a modest amount? Why not a

maximum efficiency? Because "Natural Selection," wonderful to relate, is supposed to be at one and the same time a principle of degeneration and of progress; and if more than a minimum of efficiency were to be required this would not meet the case of those legions of degenerates, the "favoured" of Natural Selection, who carry on (multiply) with a minimum of efficiency and at the cost of future ruin. The idea that some lack of efficiency is at the back of extinction is of course too tangible for Darwinism to have passed it by entirely. But is it not that the term "efficiency" has a moral and social connotation?

May it not be that in the hierarchy of beings, the most moral are also *ipso facto* the most "efficient," that different standards of efficiency as of morality are required, according to status, that in the evolution of life, too, it is a case of *noblesse oblige?* Dr. Pycraft is very careful not to tell us what his minimum standard is, and, of course, Darwinians only guess at it. They merely water efficiency down, as they have also watered down morality (representing Nature as "non-moral," by allegation, but immoral by description) so as to make these concepts square with their "mechanistic" theory of "Natural Selection"—neither fish, flesh nor fowl.

But it is in the consideration of the "concrete examples," chosen by Dr. Pycraft to show us what he is "driving at," that the futility of Darwinism becomes most strikingly apparent even on our savant's own showing. We are told: "Suppose that no fossil elephants were known, the official interpretation of the development of that wonderful organ, the trunk, would never have been suspected . . . We should have been told that it had its rise in the origin of some "ebullition" of the germ-plasm, giving rise to an incipient, flexible snout, such as that of the tapir; and that, as competition between individuals presenting varying degrees of this "diathesis" increased, those with the longest snouts would come out to oust their less-favoured rivals, till, at last, the 'trunk' would arrive."

This, of course, is the old Darwinian nonsense, which acquaintance with palaeontology can no longer afford to countenance. Hence the resort to "Lamarckian Darwinism."

What is the story of the elephant, and what does it teach? This is what we are told: "Fortunately, however, we have a wonderful series of fossil elephants, beginning with a small, tapir-like animal, and ending with the elephant as we know it. This series shows us that the ancestral elephant derived much of its food by digging in the ground by means of a pair of chisel-like teeth at the end of the lower jaw. A prominent pair of tusks in the upper jaw probably served for fighting, But it was a short-necked creature, and as it increased its stature, its neck did not lengthen to keep pace with the lengthening legs. Instead, the lower jaw increased in length. It had to, in order to enable the creature to feed. As the jaw extended, so the snout and upper lip were drawn forwards, till, at last, as in Tetrabelodon (an elephant ancestor) it became available as a prehensile organ, enabling leaves and grass to be twisted up and passed into the mouth, while the upper tusks were now capable of digging. So soon as this stage was reached, mark what happened. The reduction of the extremity of the lower jaw set in. By use it lengthened; by disuse—that is to say, relieved of this function of digging—it began to shorten, During all this time occupied by the lengthening of the lower jaw, the incipient trunk was playing the part of an "understudy," it, too was increasing by "use," until, at last, it became a more efficient organ than the lower jaw, whose evolution had brought it into being."

Now, when we come down to realities, we see the chief factors of evolution at work: food and appropriation, whilst various Darwinian bogeys, such as "variation," "acquired characters," "selection" vanish into thin air. We may now return to Herbert Spencer: "A right understanding of the laws of organic modification underlies a right understanding of the great question of species." And we may also recall Samuel

Butler's admonition : " Our modern evolutionists should allow that animals are modified not because they subsequently survive, but because they have done this or that which has lead to their modification, and hence to their surviving."

How shall we assess the survival-value of the doings of the elephant ? The elephant, it is true, has at least remained a " cross-feeder." It has not abused its great strength to the extent of killing and devouring other animals ; but it has greatly abused the plant world—the goose that laid the golden eggs—by its destructive way of feeding, tearing up and laying waste : and this has produced the most serious reactions upon the physiology and anatomy and upon the evolution of the species.

Having drawn for millenia its energy direct from the great storehouse of animal energy, the plant kingdom, the elephant was able to achieve great power of survival ; and it is, also, as is well-known, a fairly sagacious creature. None the less, as I have often stressed, it has to some extent flouted the symbiotic principle, by failing to confine itself to vegetable spare products, by uprooting plants, and by devouring them wholesale, this everywhere producing disastrous results. The elephant has indeed become what I have termed a " plant-assassin." Though specialising as a " digger," it has not in so doing helped plants, but, on the contrary habitually destroyed them. I have shown elsewhere that there is an unfailing nemesis to plant assassination. The elephant became monstrous in the first place because its appetite had become monstrous. The species suffers from acromegaly, a kind of giants' disease, and is now verging on extinction, similar to other monsters, which became anachronisms in the world of more modest creatures.

An orthodox biologist sees no more than the consequence of " use and disuse " in the development of such a species—a far too static way of viewing things. But we must employ and expand the dynamic method, introduced by Darwin, but subsequently replaced by " Natural Selection," by studying the whole bio-sociality

and bio-economics of the case, when it becomes evident that we are here dealing with "misuse"—misuse of the essential "environment."

Food involves appropriation, and thus entails the mutual relations of organisms, *i.e.*, sociological relations, and not merely, as Darwinism posits, mechanical or at best merely expedient "adjustments." Broadly viewed, the evolution of a species is in accordance with the way in which it obtains its food. Dr. Pycraft is getting on the track of the truth when he says that a wonderful thing has been revealed to him as a result of his study. A fact of supreme significance, he says, stares one in the face, *viz.*: "All animals must eat to live." Perhaps if this marvellous realisation had been made earlier, the evolution theory would not be in the muddle in which Darwinism has left it.

We are thus driven to conclude that the adaptation which counts most in evolution is socio-physiological adaptation, *i.e.*, to partners who are themselves progressive in the sense of "organic civilization." Such adaptation requires great discrimination so far as concerns food and food-getting—matters which biologists have been loth to tackle.

Heredity and environment have hitherto been considered as the master influences in the world. But in reality it was food that was the master influence, a truth which becomes the more apparent the more food is seen in its true setting.

Writing on "environment," Henry Drummond long ago pointed out the great physiological changes that may be wrought within the organism by changing its food. He had got an inkling of the idea that a change of food in practice implied a change of environment, inasmuch as it entailed a change in biological relatedness, and that this must give rise to serious reactions, serious modifications. He tells us: "Hunter, for example, in a classical experiment, so changed the environment of a sea-gull by keeping it in captivity that it could only secure a grain diet. The effect was to modify the stomach of the bird, normally adapted to a

fish diet, until in time it came to resemble in structure the gizzard of an ordinary grain-feeder such as the pigeon. Holmgren again reversed this experiment by feeding pigeons for a lengthened period on a meat-diet, with the result that the gizzard became transformed into the carnivorous stomach. Mr. Alfred Russel Wallace mentions the case of a Brazilian parrot which changes its colour from green to red or yellow when fed on the fat of certain fishes."

Clear cases of Symbiosis can be shown as with the so-called "plant-animals," for instance, where the food-procuring and food-exchanging partner, say, the green algae, is within the animal, say, the worm. Here some biologists are inclined to speak of the "internal environment" (constituted by algae), a contradiction in terms, which, moreover, draws away the attention from what really matters, namely, specialisation in universal service by adaptation to a living, reciprocal and industrious "environment."

It is evident that a good deal of talk about "adaptedness to environment" is illegitimate, since biologists do not make it sufficiently explicit what they mean by the term "environment." We should distinguish between the animate and the inanimate environment, between that which is friendly and sustains us, and that which, on the contrary, is inimical and injures us. We should also make sufficient allowance for the fact that the organism itself is to a large measure responsible for its environment. An organism may be, so far as appearances go, well adapted to certain features of its surroundings ; but it may none the less be ill adapted from the point of view of conformity to the progressive scheme of things ; and such distinctions are all-important to make.

I shall have much more to say on these matters in a subsequent volume.

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SYMBIOSIS *v.* CANCER

BY

H. REINHEIMER

Author of "Evolution by Co-operation," "Symbiogenesis," "Symbiosis," etc.

WITH A PREFACE BY

SIR WILLIAM VENO

LONDON

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PREFACE

MUST we always regard cosmic warfare as one of the eternal verities or may we revise our view? In the following pages Mr. Reinheimer gives us an admirable picture of benign and symbiotic altruism governing the realms of biology and sociology. He rules out what has been regarded as the fundamental predatory instinct of all living organisms as abnormal and immoral.

It is not possible for a mere business man to specialise in such a subject as this. To collect the evidence necessary to support such a theory is a matter of prolonged and arduous labour, it requires the trained mind of the student. But after all, real science depends upon rudiments and fundamentals rather than upon detailed demonstration, and from this point of view I may say at once that I am in agreement with the theory of Symbiosis expounded by Mr. Reinheimer. If I make any reservation at all, it is because I am perhaps not so idealistic in general temperament as this very gifted observer. I would very much like to believe that the first primordial protoplasmic nuclei—the original algæ and amœbæ which represented the bio-genesis of this planet were conformed naturally for the purpose of mutual assistance, and that all predatory tendencies were non-existent. I would like to think that in subsequent evolutionary progress, ethics and æsthetics could, but for unintelligible abnormalities and accidents, have led to Biological utopia and the exclusion of murderous parasitism and disease. But to me, the

matter offers many loopholes for disturbing speculations —my mind has not in the perusal of the scholarly pages of Mr. Reinheimer become so sedate as to function entirely along these lines.

However, though I may have some qualms of honest doubt as to the universal application of the theory of Symbiosis, I feel that to take the opposite view is hatefully irrational. Neither in biology nor in sociology can I bring myself to believe that predatory and parasitic tendencies and instincts are the normal concomitants of organic life. If we cannot aspire to a more benign view of the universe than that, then it makes the whole cosmos entirely unworthy of even the sophisticated symbiotic intelligence and influences which it has evolved.

Those who know my views on the origins of disease, and particularly on the causation of Cancer will be aware that I have arrived at the conviction that this terrible scourge is a direct outcrop of civilised living. A casual observer will note that if there be any truth in this view, it is a direct testimony to the general truth of the theory of Symbiosis. But I am quite certain that the underlying truth of the statement has equal bearing on other diseases which cannot be described as essential diseases of civilisation. To my mind there is little doubt that all disease is an indication of lack of hygiene in dietary, conduct or manners. The diseases of filth and dirt, the venereal diseases, even such scourges as malaria and filaria, and the dread leprosy are outstanding examples of what I refer to. To take one instance—that of comparative immunity, not arising from inoculation. It is an everyday occurrence to find individuals braving unscathed the dangers of a virulent epidemic. In my own experience I have known men who could afford to ignore the presence of the malarial or filarial mosquito.

I think too, that reliable statistics prove the relative immunity of the black races as compared with the white in the case of cancer. Well, to what does this point? Immunity is a mere term. To state that one human system is capable of greater resistance than another is merely to say that one man is more healthy than another, and if we are prepared to go no further than that we merely beg the question.

But I think we may go further, though in so doing I expect I shall challenge the criticism of orthodox science. In my opinion the causation of disease has no relation to its possible cure. Health is a matter of pure physiology. Materia medica represents experimental dabbling which bears a close relation to the proverbial search for the needle in the haystack.

I am convinced that all disease—so called—arises from human departure from ascertainable biological ideals. If you grow a legume without potassic food, it fails to mature; if you reduce its supply of its own proper food, it contracts disease, parasitic and otherwise. If you feed it overmuch you have an exactly similar result. There is in my opinion a perfect analogy with the human organism. If we say that cancer is a disease of civilisation, we can surely in due course discover at any rate a symbiotic preventative, even if we fail to discover a universal palliative or cure.

I am not able to suggest actual channels of research. But let us use the analogy of the legumes again. Purely chemical constituents of the organisms of this family include predominant amounts of nitrogen, phosphorus and potassium. The individual amounts vary as you observe root, stem, flower or seed pod. If you diminish the supply of one or increase that of another, you get puny or abnormal growth as the case may be. And, by

the way, this family supplies a charming example of symbiosis. I refer, of course, to the particular nitrogen bacillus which occasions the very familiar root nodules. Well now, it is possible for the chemist to build up a " complete fertiliser " as the result of ordinary chemical analysis, and that complete fertiliser is successful to a most wonderful degree. It adds to the health, fruitfulness and length of life of the plant. Take another point—which also seems to me to be suggestive. Apart from the outstanding chemical factors of the structure of the plant, there are minor details which do not seem to possess so much importance, but which obviously must have direct bearing upon its life and health. Accidental osmosis will not explain the presence of minute but unvarying proportions of given salts, it may be that some of these traces have very great importance.

By judicious feeding with proper food—and that food, it should be remarked, is always elementally identical with the basic constituents of the organism of the plant —the amateur gardener will tell you, you can produce robust, healthy, even giant growth. But if you feed a plant with anything at all which is outside the natural eventual material of its state of maturity, as likely as not you kill it.

I think the search for the life elixir which has been conducted throughout the ages, should be carried on from the point of view of health and not of disease. It is inconceivable, for instance, that by giving a pea or a bean a solution of copper, arsenic, mercury, or any other mineral substance outside its own mineral constituents, you could eradicate a particular disease, but even so, you would still leave a state of ill-health, for you would vitiate the sap with substances which never enter into the composition of a healthy pea.

I am well aware that on top of all this there is the question of environment, habit, surroundings. The legume is very susceptible indeed to weather influences, to variations of heat and cold. It prefers sunlight to shade. It likes a light compost in which to grow. And, of course, you cannot uproot a man and plant him somewhere else, the most you can do is to take him temporarily out of what may appear to be unhealthy surroundings, and to put him into approximately the state that his condition may seem to demand.

But to put the matter into a nutshell, I have a conviction that we begin to approach the truth when we take up the study of the vitamines. At present they are not formulated with anything like exactitude, but whether disease be due to an excess or a deficiency of any material whatsoever in the human system, the typically healthy body, viewed from the aspect of the chemist's balance, represents the ideal to which we should always strive. And I hold, too, that health gives the best immunity against parasitic disease.

It should not be impossible to find, shall we say " the complete fertiliser " for the human body, and when it is found I am optimistic enough to believe that it will be more or less of an elixir of life. I do not wish anyone to suppose that because I have insisted upon the fact that cancer is a disease of civilisation that the secret will be solved by a mere comparative examination of the statistics of the dietaries of uncivilised and civilised communities. I would rather maintain that there is a generic and basic cause of all disease, and that that cause is to be found in deficiencies or excesses of which perhaps the whole human race is unconsciously guilty. Our food becomes more and more a matter of taste and appetite. We eat what we like rather than what we

need. And we force ourselves to acquire tastes for things that are not good for us. In the original order of things—the symbiotic UTOPIA as conceived by Mr. Reinheimer—there was undoubtedly, as he said, a perfect balance between one protoplasmic unit and another. The apparent parasite was a virtual assistant, the host led it about to find new food pastures, it in return gave definite and practical service. The predatory ravishing instinct, which the scientist of the approved *église* would have us believe is the natural law of the living cosmos, had no existence ; it was not that artificial self-abnegatory altruism which I fear so often fails to justify itself in this modern world, which was at the back of this well-mannered state of primordial existence —it was another form of altruism altogether, the altruism of expediency. And the world, whether suddenly or gradually, will have to see the truth of this. We shall have to get back to the simple life in this way and from this point of view if in no other.

Otherwise, disease will be rampant and the unfettered scourge of parasitism will rule the earth.

WILLIAM H. VENO.

INTRODUCTORY

AMIDST much that is uncertain with regard to cancer, one undisputed fact stands out: the cancer-cell is a parasitical and even cannibalistic cell. It battens selfishly on the bodily substance, without duly metabolising it, storing it, or transmuting it to the benefit of the polity as a whole. Cancer, therefore, calls imperatively for an elucidation of parasitism in Nature. A correct appreciation of parasitism would mean a considerable step towards the solution of the problem of cancer. The character of the cancer-cell is ominous; and the whole case is calculated to render parasitism suspect. The suspicion is that parasitism is an anti-social and malign influence, inimical to integration and antithetic to integrity. This is in keeping with the facts stripped of misleading details.

We must look to an opposite—a social and benign—principle as the safeguard of health and of progress. This we find in Symbiosis; and there are thus two well-marked and opposite pathways of evolution—the one leading via Symbiosis to health and progress, and the other via predacity and parasitism to disease and decline. Momentous issues are here at stake. They involve not only medical and physiological, but also biological and sociological science.

But where are we to get comprehensive views in this world of specialism? Some years ago, Professor Patrick Geddes stated in a preface to a work by Massart and Vandervelde on "Parasitism, Organic and Social": "May we not hope one day to see an antithetical title to the present one—Symbiosis, Social and Organic? Neither economist, nor naturalist is ready to write such a book."

So far as orthodox biology is concerned, the goal is not in sight. The problem calls for the establishment of a new department of biology: socio-physiology, involving a long overdue amalgamation of several collaborating sociological and physiological factors. Once this is accomplished, the road is open for a comprehensive view of disease and of degeneration, and of the causes that lead up to them. It should never be forgotten that Nature, too, has her sociality, that behaviour and interdependence rank high as determinants of health and of evolution. In Nature, as amongst men, it is the Golden Rule that those who do the things evolve the powers; and it is thus true that physiological follow in the wake of sociological developments, and that frequently the two go hand in hand or follow parallel paths.

Ever since 1909 I have put forward the theory that parasitism is abnormal and even pathological. This view was, and still is, diametrically opposed to the orthodox one, which regards parasitism as normal. I have looked sufficiently into the matter, however, to feel satisfied that the official view is not so much due to any profound investigation or deliberate and consistent thinking, as to a facile acceptance of a faulty tradition. Pathology has not received the attention it merits, with the result that on many important matters artificiality and arbitrariness prevail. What unanimity as regards parasitism there exists, is founded on the bias of the pioneers of physiology rather than on scientific verification.

It has been with the problem of health and disease much the same as with that of good and evil. Prejudice, and partly also ignorance, have barred the way to progress. Part of this attitude may be regarded as a counsel of despair. For we lacked the means of establishing a valid standard of values in biology, to which

we might refer good and evil, normal and abnormal living. If we possessed the apposite data, we could work with a kind of biological relativity, based on which we could soon award a niche to good and evil, and evolve a guiding principle to apply to health and disease. Candour demands the admission that there has been nothing more disconcerting in the whole realm of science than our embarrassment with regard to good and evil, i.e., values.

Religion with its quasi cosmic standards, backed frequently by the sanction of millions of years of human experience, has a much higher claim of merit so far as these issues are concerned. I for one, see no good reason why science should fight shy of any truth that is to be found in the religious camp. Quite the contrary; and I can see the possibility of good results springing from the collaboration of science and religion.

But there is a way, and a very satisfactory one, as I have discovered, to introduce the idea of moral standards in biology. I suggest that we must look for a code—a "codex" of Nature, to use a term of Dr. John Clarke's, an American paleobiologist, who, not very dissimilar to my views, urges that in Nature's programme physical salvation is reserved to the few and is the reward only of righteous living. This code, or Golden Rule, must be one, compliance with which is incumbent upon all organisms, in virtue of their very constitution (with its law and order) and in virtue of their unfailing dependence on others (which similarly involves eternal law and order).

Such a Golden Rule exists, I contend. It is born of the fact of co-evolution between plant and animal and the concomitant primordial pact of mutual aid between the two, involving a code of biological duties: the

analogues of those observable amongst the organs of the individual body—involving in short the law of the members. That is to say, that organisms are not free, as was held hitherto, to go as they please and to indulge their appetites *ad lib*; but it is normal for them to behave in accordance with the system of ordered freedom in which they live and have their being, and the fundamental laws of which cannot be violated with impunity. No organism can say to another: "I have no need of thee"; and this involves, normally, instincts of solidarity, concerning which more will be said in the context.

Here, then, we have a standard of biological legitimacy: developments are good or evil, normal or abnormal, according to their bearing on the co-evolution between plant and animal.

I have long tried to base evolutionary pathology on the fact of a divorce from Symbiosis, since this involves malobservance of the fundamental bio-social treaty that binds together the world of life; and it can be shown in a thousand ways that disobedience to the implied bio-moral law produces evil. It leads, in the first place, to an abnormal metabolism, and thence, via self-poisoning and infection, to disease, to monstrosities, to decline and extinction.

An animal, for instance, which accustoms itself retrogressively, i.e., contrary to the established symbiotic order of Nature, to respire nitrogen instead of oxygen, is certain to engender an abnormal metabolism, relative to the fundamental pact of organic life, and *pari passu* to turn increasingly evil, both as regards its equipment and its character. It turns evil inasmuch as it increasingly frustrates the highest purposes of the organic community, which require the good of the whole to take precedence of that of the individual. There is, therefore,

a clash of interests as between good and bad organisms, and an ever-increasing antagonism, ending finally in the triumph of the good. Evolution is in the main the development of a moral principle, whatever the appearances may be to the contrary.

Again, a plant which ceases to draw its sustenance laboriously from earth and atmosphere, develops an abnormal metabolism and becomes *pro tanto* evil. Such a plant loses its capacity of elaborating substances useful to organic life, which capacity is a means of ensuring it, within its own limitations, a front place in organic civilisation. It loses, further, its woody fibre, its power of photosynthesis, its faculty of aiding the evolution of the animal in accordance with the ordered and beneficial co-evolution of life on our globe. Animals cannot synthesise Vitamines. They must go to the plant kingdom for them. It has been found that the manufacture of Vitamine A, for instance, is dependent upon the presence of photosynthesis. This Vitamine does not appear in the seed until the photosynthetic process begins. A plant that fails in photosynthesis, therefore, can do little to further the interests of co-evolution.

With a parasitical organism—one that has, like the cancer cell, flouted Symbiosis altogether—sanction after sanction is lost, precisely as in the case of moral pathology amongst men. An organism turned parasite becomes confused. Evil becomes its good, and good its evil. It has an interest in disorder. The bio-moral atrophy is the unfailing concomitant of the structural atrophy, for which the parasite is notorious. In Nature as amongst men, the inexorable law of moral consequences thus holds good. There is abundant evidence to show that a parasite forfeits increasingly its sense of proportion, its power of orientation in the world of life.

The notions of hell, fantastic though they were, stood for a truth which we cannot ignore. The attribution of "non-morality" to Nature by orthodox biology is to some extent a device for shelving the difficulty of dealing with biological good and evil.

A plant of abnormal metabolism also turns faulty with regard to the provision of oxygen, carbon and calcium.

It is not commonly known that calcium is indispensable to phanerogams, and cannot be replaced by magnesium, for instance. But calcium is indespensable to animals, too, who obtain it from the plants. Certain non-chlorophyllaceous types of plants, however, having thrown photosynthesis to the winds, can thrive without it. Their metabolism is *pro tanto* bad and abnormal; it antagonises the normal course of evolution, according to which it devolves upon the plant, at certain stages of evolution, to elaborate calcium salts and to provide surpluses which can be spared for the symbiotic animal. In the place of useful substances, such backsliding plants will manufacture poisonous ones, which strikingly marks the deterioration of the metabolism, and the relatively evil character of their habits and activities. These plants are involved, not in Symbiogenesis, but in Pathogenesis.

Calcium, carbon and oxygen are indispensable to animals. But there is only one system in the world which we could trust for the provision of right amounts, right qualities, and right combinations—for, in order to be of the highest avail, even the rightful substance need to be duly tutored and proportioned—and that system consists in the main of the evolved Symbiosis between the "kingdoms," with its ordered freedom, and its manifold beneficial dispensations and regulated stimulations, a system into which nothing will permanently fit that is not amenable to cosmic usefulness.

I have termed this system "Norm-Symbiosis," in order to distinguish it from minor and seasonal forms of co-operation—those relatively unimportant cases, to which official biology alone attaches importance. Norm-Symbiosis, with its well-controlled activities, its reciprocities and compensations, its industrious habits and peaceful dispositions, its momenta for biological righteousness, provides the "Leit-motif" of organic evolution. It represents the legitimate and dominant relation.

Co-operation and compensation are inherent in the very constitution of organisms. They are eternally indispensable principles; and this is the justification for basing biological relativity on the respective standards of behaviour. It is clear that, according to this line of argumentation, the orthodox view of parasitism is thoroughly untenable. I have already suggested that that view has very little claim to finality. It is not based on sound philosophy and sound science, but merely superficially upon bad philosophy—that of Dr. Pangloss that whatever is, is best. There is evidence that all is not plain sailing on this official view. For some biologists feel constrained to plead that parasitism, if it be not abnormal, is at least "otiose." Such equivocation shows the impossibility of banishing good and evil from biology. In one form or another these concepts return. Neither is it saying very much to state that parasitism is a successful adapation. For the statement is usually unaccompanied by a criterion of success.

The theory of natural selection posits reproduction and adaptation as the criteria—poor palliatives for what is lacking: a valid standard of values. For, as is seen in the case of cancer with the excessive proliferation of the morbid parasitical cell, reproduction may proceed pathologically, i.e., in opposition to the true interests of

the part and of the whole. It may proceed at the expense of status and of future well-being, i.e., attended by negative compensations. Such compensations are constantly being incurred, and must be duly accounted for, and this not merely in a morphological but in a qualitative sense, if confusion is to be avoided.

The modifications suffered by a parasite are marked by negative compensations and are not at all on a par with those exhibited by progressive organisms, which are marked by compensations of a positive order. The two are due respectively to two different principles, and they cannot be fitly compared unless we draw these distinctions. On a long view, moreover, parasitic adaptations are anything but successes in evolution. They are, on the contrary, suicidal.

According to Dr. John M. Clarke, the paleobiologist referred to above, the cirripede crustacea, and many like cases, show a wonderful adaptation of their physiology to their adjusted requirements. Yet these wonderfully protected and adjusted creatures have not been the source or starting point of any progressive development in the animal world. They are moving slowly under their protection into an ever more hopeless state; and examples quite as explicit in their teaching permeate the more advanced groups of life. Dr. Clarke tells us that such creatures have lost their grip on normal living (constituted by independence, according to his theory) and that with them the infant stage is the only faithful reflection of the dignified past.

I should say that they represent misadaptations and anachronisms, from the point of view of co-evolution; and that, hence, they are abnormal and backward organisms, disqualified for any place of importance in the hierarchy of life. They are at the same time involved

in a protracted pathological process, and to the trained eye the stigmata of disease are seen to abound.

Paleontologists declare that we are here dealing with "specialisation-development, carried from usefulness into disadvantage."

But what is to be our standard of usefulness? Can they tell us the safeguards by which such suicidal consummation is avoided in normal evolution? They cannot; because they ignore Norm-Symbiosis. The normality which was in the beginning, they set down to unexplained directive processes; whilst many regard the subsequent overdose of specialisation as inevitable and somehow founded in the nature of things. All of which is unsatisfactory, unconvincing, and vague. "Over-specialisation" plays the rôle of a *deus ex machina*. One might think, on meeting with such explanations, that bio-economic and physiological factors have never entered into the scheme of things, so thoroughly has orthodox science here left them out of the reckoning. To explain failure by "over-specialisation" is like saying that cancer is due to the cancer-cell overdoing something, we know not what. But, conceivably, since there are also sins of omission, it underdoes something. And here as there, that vital "something" is just this: co-operation—a fair measure of which is required from every organ or organism if it is to secure health and status.

Unfortunately, Darwin's theory of natural selection has greatly abetted the belief in the normality of parasitism, and has thus retarded not a little the understanding of disease in general and that of cancer in particular. It is perhaps not to be wondered at that even the sagacious Darwin fell a victim to the prejudice with regard to parasites. For in matters appertaining to disease we are up against a common human failure:

not to look the facts honestly in the face. Instead there is a lazy compliance with low conditions. Hence, if pathology is backward, the blame rests primarily with our common humanity and its failings. It is a case of *totus mundus stultitiat.*

Dr. John M. Clarke is one of the few biologists who recognise that parasitism is abnormal and even unrighteous. In his recent book on " Organic Dependence and Disease," he traces the origin of disease back to the earliest forms of life ; and his conclusions have called forth the following lament on the part of a reviewer in the *Times :* " It is a little depressing to reflect that disease is nearly as old as life, and that the system of life to which it belongs has its roots extended so far and deep throughout the animal kingdom."

In other words, we quail at the idea of a reign of law in matters of disease. There is a strong indisposition amongst us to view disease in the light of law. We prefer to repress the unpleasant matter and even to style ourselves the rebels of Nature, which, moreover, is a philosophy conniving at indulgence rather than encouraging the subordination of wayward instincts to control. Instead of amending our ways, we make responsible for our misfortunes—often the surfeit of our own behaviour—the heavens, the stars, and the moon, and the " struggle for existence." It is a common attitude, even amongst men of science, to vituperate scientific evidence, if it run counter to their preconceived ideas. Hence we have never adequately realised how consistent and utterly trustworthy Nature is ; and, hence, too, we are apt to place our reliance upon false remedies and to worship at the wrong shrines. Instead of elucidating the problems of disease and of the interdependence of life, we have pinned our faith to a kind

of pagan entity : natural selection, which has become a cult. Those who have insisted on the teaching of this theory have, in their zeal, done as much harm to science, as the Torquemadas did to religion. With prophetic vision Huxley foreshadowed the damage done by the uncritical acceptance of natural selection.

The theory of natural selection is partly dialectical and partly metaphysical. It invokes " elimination," but is quite inadequate to account for the chief eliminative process, as constituted by disease. It invokes (somewhat metaphysically) " preservation," but is totally inadequate to account for the positive, integrative factors that make for stability, permanence and success. The " sieve " of natural selection is supposed to do what vigilance and good habits alone can accomplish. Belief in the " sieve " saved troubling about pathology, and really made it very difficult for students to get on with pathology. A few pathologists have seen that human maladies are but a narrow fringe along the border line of disease. But Selectionists still frigidly maintain, notwithstanding the evidence, that wild nature cannot harbour disease. Whatever is, is best ! If it be not best in a general way, it may at least be good in a particular way—in a way, for instance, in which the cancer-cell is " good," namely, in mere expediency.

A few distinguished biologists, including Prof. Bateson, in this country, and Prof. E. B. Wilson, in America, have felt the incongruity of the position, and have not hesitated to speak out. Bateson pointed out that the ignorance of common facts bearing on certain parts of the inquiry which prevailed amongst evolutionists is astonishing and inexplicable. " What glorious assumptions went without rebuke ! "

Wilson stated : " Too often in the past the facile

formulas of natural selection have been made use of to carry us lightly over the surface of unsuspected depths that would richly have repaid serious exploration "—a pregnant remark, more pregnant than was probably intended, as those who will bear patiently with me to the end of this volume, will realise.

It may be as well to tender some further justification for the decided stand that I have taken. My views are primarily based upon observations—observations of relevant facts, the full significance of which has been gradually and steadily maturing in my mind as I learnt to apply my results more generally. Much insight I gained as a student of medicine, particularly by the study of the early symptoms and causes of disease—a subject which the schools have neglected, although it is one second to none in importance. It has been a great eye-opener to me. I learnt to separate the physiological from the pathological. There can be no clarity of thought unless we are able adequately to make such separation. Neither can there be a due appreciation of the range and significance of pathological processes ; nor, for that matter, a correct appraisement of physiological processes. Unequipped with this knowledge, one can scarcely hope to acquire vision enough to penetrate far into the depths of biological sequence. Those destitute of this knowledge scarcely realise how ridiculous they make themselves by sitting in judgment upon one whose vision they cannot rival.

All the great issues of biology are to-day confronted by the problem : Where does physiology cease and pathology begin. Because this question has not been satisfactorily answered, many things in biology have remained enigmatical in the extreme. This is a recent statement of the predicament of biology by a medical

man, Sir Archdall Reid, whose communications to *Nature* during 1921 formed quite a feature of that publication: "Consider the chaos of biological sects and opinions. . . . Consider the enormous masses of neglected evidence. . . . Consider what happens when a humble outsider such as myself brings his difficulties to biologists. He is told pontifically that he is doing harm, or conceitedly that biologists are quite capable of conducting their deliberations without his help, and so on. The feelings of awe and admiration excited in the humble inquirer are then likely to be—well, of no importance."

So, with regard to medicine, we were told by Sir Clifford Allbutt (*Times*, 8th December, 1919): "The great lines of medical progress, being indeed of yesterday, are scarcely reaching beyond the anthropocentric orbit; they must be enlarged and blended with other lines of pathological research on a Copernican conception. . . . But this unity, if we are to grip principles at their beginnings, means not merely the beginnings of disease in men, but also in all animals, as they are alike for all; and not of animals only, but also of plants; in a word, of all life. . . . And yet in respect of a plan or system, comparative medicine is still without even a sketch, almost without a thought."

Evidently there are some gaping apertures in biology, which no amount of "natural selection" can bridge. An entirely new synthesis is wanted. It is true, however, that before this can be fully accomplished, a number of cognate subjects require to be brought up to date. The study of the early phases of disease has long led me to the appreciation of the enormous importance of food. I may be permitted to say that I have stated my views as early as 1900. The food factor, until quite

recently, had been entirely shelved. It was taboo—probably in deference to the frailty of human nature.

It took a Great War to evoke an appreciation of the importance of food, both individually and nationally. We should not be surprised to-day at the prevalence of cancer in our midst, seeing that in the past the acme of scientific wisdom in matters of diet was held to be this : follow your instincts.

There are good and bad instincts ; and the bad, which have had far too long a vogue, and are based on selfishness, have had precisely the effect of promoting a vicious egotism, a fictitious autonomy, of some of the tissues. This has led to the undoing of that symbiotic harmony and subordination which are the only safeguards of health. In this degeneration some tissues finish by becoming entirely predaceous and even cannibalistic. We get a dominance of the lowest elements—such is the nemesis of a divorce from Symbiosis.

Dr. J. A. Murray, the Director of Cancer Research, has recently told us (*Nature*, 9th March, 1922) that a start has been made to ascertain the food requirements, general and special, of tumour cells ; " but these experiments are still too slightly advanced for us to know whether any result of positive value will be obtained."

Meanwhile, however, are there not some important lessons to be gleaned from the food requirements of parasites in Nature? Parasitism is fostered by super-abundant nutrition, by a " royal diet " ; and we may feel reasonably sure from this and other evidence that protracted offences against dietary laws are at the root of cancer.

I have set forth some guiding principles of diet in an article on " Symbiosis and the Biology of Food," in *Science Progress*, October, 1921. But I have given prominence to nutrition in all my earlier writings.

Some twelve years ago, I was told by one of our leading medical journals to go to India in order to convince myself of the falsity of my views. I declined the advice, feeling that I had sufficiently checked and counter-checked my observations in Europe, and that they did not require corroboration from Asia. But it so happened that a recognised medical investigator, Dr. R. MacCarrison, actually did study diet in India, and, *mirabile dictu*, in the same journal that censured my findings, he publishes views identical with mine.

Dr. MacCarrison's conclusions as regards the duties of those who are guarding the national health are (*Lancet*, 4th February, 1922) : "The first to instruct the masses as to what to eat and why to eat it ; the second to apply the result of our science to the production of natural foods in abundance and to their widespread and cheap distribution, rather than the erection of institutions for the treatment of maladies due to their want ; the third, and most important, ardently to pursue our investigations and the acquirement of knowledge."

With this, too, I am, and always have been, in entire concurrence. I am confident that my views with regard to Symbiosis, parasitism, and evolutional pathology, will prevail in the end no less than did those with regard to nutrition.

A young and enthusiastic biologist from Oxford, Mr. J. S. Huxley, has conceded some value and originality to my views. This is what he says in *Discovery*, June, 1921 :

" Briefly, his (the present writer's) thesis is this : that co-operation between members of different species —in other words, symbiosis in the broadest sense— is the only mode of existence which makes for biological solvency and biological righteousness. He believes that

you can draw up a system of Evolutionary Economics, and can see which modes of life result in an excess of expenditure over income, which lead to a growth of capital; nay, more, that an ethical flavour may be properly introduced into our evolutionary thinking, since only through symbiosis does life achieve its true destiny, which is progress.

"Now, Mr. Reinheimer is right in a number of very important points. He has seen the wood that so many professional biologists fail to perceive for the trees—he has a clear idea of biological progress; and he has gone further than that, and stressed in a very original and suggestive manner the value of biological co-operation, of symbiotic modes of existence, for achieving such progress."

Indeed, Mr. Huxley thinks that if I could make good, I might find myself ranked with the Newtons, or Kants, or Darwins, or Einsteins. But there is also the professional in Mr. Huxley, and he betrays the "slow-consenting, academic mind," diffident to accommodate itself to a new orientation.

Mr. Huxley proceeds to doubt that I shall make good and recants from his favourable first impression, suspecting it to be due to a snare. Seeing that the book has impressed him to some extent and that it gives evidence of a vision not usually vouchsafed to professionals, who might thus be put in the shade, there has to be some abatement in the meed of praise. My critic insinuates that if I have been able to travel far, this must be due to my riding on a Hippogriff. He declares that my views regarding evolutional pathology do not "wash"—although I am not aware that he has a better theory. Evidently he realises that my views are somewhat revolutionary, and that if they should prove true, he

would have to burn much that he had learnt and cherished, and to learn what he had burnt. This he is as yet loth to do—at least in public. His alternative is to burn the "Einstein." It has been customary in the history of human thought to see contumely heaped upon the pioneers who have quarried new truths from primal sources, and it looks as though it ever would remain thus.

I doubt that Mr. Huxley realises how bad the case of the professional frequently is. Let me tell him of some mordent candour from one of his own class—one well qualified to speak. According to the late Prof. William James, the Professor is the natural enemy of his subject, and "the spectacle of a professor who has triumphantly destroyed his subject, and is flourishing on the proceeds of his crime, is familiar to every academic institution."

This is by no means an isolated view. Others have warned against the danger of science becoming so stereotyped that it may retard progress. In the *Times*, 27th June, 1922, we read, under the heading "The New Medicine—American Doctor's Views of English Work": "One of these visitors told the writer that he had confirmed an opinion formed ten years ago that the strength of British medicine and surgery lay in its 'nonconformists'—the progress has been 'extra-scholastic.'"

The professionals have succeeded in killing one subject: parasitism. I am endeavouring to rescue from a like fate another, equally important: Symbiosis. It is a work that I feel I must not neglect, though it may not be my business to complete it. I feel that I have sown the seeds from which none but good fruits can arise. Sooner or later this will be widely recognised. Meanwhile I stand and work and wait.

" What a parade we make of our science. And how far off, and at arm's length, it is from its objects ! Our botany is all names, not powers ; poets and romancers talk of herbs, of grace and healing ; but what does the botanist know of the virtues of his weeds ? . . .

" All our science lacks a human side. The tenant is more than the house. Bugs and stamens and spores, on which we lavish so many years, are not finalities, and man, when his powers unfold in order, will take Nature with him, and admit light into all her recesses." EMERSON.

" The divisions between physiology, pathology and biology are responsible in a very large measure for the slowness with which they all advance."

MORLEY ROBERTS.

" Physicians and surgeons are not alone in entertaining the interest thus awakened, but share it with a wider army of pathologists, physiologists and biologists, who may regard cancer as a perverted form of growth, perhaps induced by an aberrant type of metabolism. . . .

" A start has been made to ascertain the food requirements, general and special, of the tumour cells, but these experiments are still too slightly advanced for us to know whether any results of positive value will be obtained. . . .

" As before, we are confronted with the unexplained and unco-ordinated powers of proliferation shown by the tumour cells."

DR. J. A. MURRAY (*Nature*, 9th March, 1922).

SYMBIOSIS *v.* CANCER

THE merest outline of its evolutionary achievements shows Symbiosis to be a phenomenon of the highest importance. The genius of organic life achieved its stupendous conquests in the main by peaceful endeavour. It had recourse to tactics that have since been so profoundly sanctioned by the experience of life as to become again of special and indeed paramount importance in our own life. So true is this that our future may justly be said to depend upon the resumption of those identical tactics which have successfully, if inconspicuously, led to the chief progress of organic life on our globe. These tactics involved, on the material side, the use of chemistry, on the sociological, or biosocial side—that of co-operation.

The fixation of atmospheric nitrogen was one of the earliest problems of organic life, and the successful solution of the problem one of life's greatest triumphs. It was the plant which here, as in many other important ways, anticipated by long ages the inventions of man. The importance to the organic world of plants which force nitrogen to combine in a form useful to living beings is almost inconceivable. But for such supplies of nitrogenous food, life itself would become impossible in the world. Bacteria and fungi are prominent as vegetable "chemists," active in the fixation of nitrogen. A bacteria-less ocean and a bacteria-less earth would soon be inhospitable either for plants or animals.

Bacteria-like organisms prepared both the ocean and the earth for the further evolution of plants and animals.

Not only did these lowly organisms fix atmospheric nitrogen, but in due course they carried the process to the nitrate terminus. The secret of their power lay, at least in great part, in combination, in division of labour, in co-operation. *L'union fait la force.* The chemical powers developed increasingly in proportion as these organisms learnt to combine their forces according to the principle *do ut des.* Chemical equipment and inventiveness were not enough ; the genius of organic life had at the same time to solve the problem of association, of the mutual accommodation, of living things. The requirements of a living, delicate, and complex industry are many, and it is futile to imagine that they do not likewise involve many correspondingly delicate requirements on the physiological and sociological side, such as definite kinds of food, for instance, and definite dispositions for " work " and for mutual forbearance.

Nitrates represent an end-product. They are produced in stages and with contributions by different organisms. That is to say, their manufacture requires systematic mutual industry on the part of many organisms, or, as it is also called Symbiosis. Typically symbiotic bacteria are *Nitroso monas* and *Nitrobacter.* The former lives on ammonium sulphate, taking its energy from the nitrogen of ammonium and forming nitrites. It has, however, formed a life-partnership, or Symbiosis, with *Nitrobacter,* as a result of which the latter, using the nitrites supplied by *Nitroso monas,* is capable of oxidizing them into nitrates.

Now the coming of the higher plants and of the animals was dependent upon the presence in sufficient quantities of suitable nitrates in the soil, and the number

of plants which at the present day live in active Symbiosis with bacteria and fungi is legion. The higher plant is able to spare some of its carbohydrate surplus in exchange for nitrogen, and it has been found that a continuous supply of carbohydrates from the green plants is a prime condition of the nitrogen synthesis. The great steps in the evolution of the higher forms were without exception based upon a succession of ever higher but similar forms of life-partnerships. Darwin held that all plants and animals are descended from a common ancestor. The symbiotic division of the descendants into plants and animals was probably the greatest single step in advance made by life. The two " kingdoms " remained essentially complemental, and, fundamentally, they still stand to each other in a relation of Symbiosis. In the same sense, Symbiosis was the secret of the general diversification of life on our globe, of the successful conquest of the sea, and, subsequently, of the land by organic life, as the following example is well calculated to show.

In some cases of alga-cum-sponge Symbiosis in the sea, the alga branches profusely and ramifies through the canal system of the sponge, the alga using for food the carbon dioxide given off by the living sponge tissues, obtaining its salts from the water passing through the canals, and, on the other hand, supplying the sponge with the oxygen given off in photosynthesis. What emerges is this : the sponge needs a particular substance, which the alga knows how to manufacture, and which the latter can well afford to surrender in exchange for a spare product of the sponge. Given a situation such as this, given, in other words, a pair of opposites to be adequately accommodated, given also sufficient disposition on the part of the opposite parties, the opportunity

is provided for a continuous process of mutual stimulation purporting increasing mutual benefits, and conducing in the result to increased specialisation, increasing capacity, and efficiency, and increasing yields, not only to the partners, but also to life generally, which is thus the richer for the adoption of the symbiotic mode of life wherever met with.

Needless to say, the plant can serve the animal the better, the more it can in turn reckon on counter services. Actually the plants have steadily increased and improved their yields, in proportion as they were able to rely upon an increasing adequacy of animal services. That the plants have succeeded in constraining the animals to numerous counter-services, on the principle of *do ut des*, is a well-known fact. Fruit-eating animals have in many ways been made instrumental in the dispersal of plants over our globe, and this very reliably so. If the respective plants were thus favourably circumstanced, this was due to their having (unconsciously) understood and mastered the secret of Symbiosis.

Again, the constant " crossing " of plants, effected by animal agency in cross-pollination, is an important factor in the viability and evolution of the plant. The plant can well afford to succour the pollen—or nectar —seeking animal in return for vital symbiotic services.

By means of Symbiosis, plants and animals have rendered both the sea and the land progressively hospitable to each other. On the land, as in the water, the plants have led the way. Without the plant, the animal could not have made a home upon the land. Food, moisture and shelter, all had to be supplied by the plant, if terrestrial life was to be permanently successful. Here as in the waters, the plant has known how to drill the animal into habits of Symbiosis.

In the important transition from maritime to shore life, a preliminary step in many cases to a more complete terrestrial life, many animals, such as the tiny flat-worm *Convoluta roscoffensis*, have found it essential to take their plant partners with them. These animals harbour green algæ within themselves, with which they live in a relation of (seasonal) Symbiosis, and this gives them a wonderful independence so far as outside food supplies are concerned, and it is thus a great aid in the accomplishment of a big step in evolution.

In its earlier youth life served an apprenticeship to the tides. That is what biologists mean when they speak of the shore as the school wherein many of the most important lessons of life were learnt. But they usually overlook the most important of all : that of co-operation, which here, too, has played a pre-eminent part.

The Amphibians, which are in many ways typical of the successful transition from aquatic to terrestrial life, have frequently made use of intra-cellular Symbiosis. Frog-spawn harbours frequently in the small chinks between the spheres, groups of green unicellular plants, which liberate oxygen in the sunlight and use up in exchange the carbonic acid gas which the developing eggs produce.

It is only beginning to be realised that intra-cellular Symbiosis is a wide-spread phenomenon. Many animals, especially insects, regularly harbour in their bodies bacterial or fungoid micro-organisms, which reside in special cells, the so-called mycetocytes. These cells are almost as another tissue of the animal. Sometimes they are formed into special organs of characteristic structure. In many such cases there obtains an important reciprocity of service between the two organisms.

Plant-animals is the name that has been applied to such associations, especially to Infusoria, Polyps, Corals, and Worms, which harbour their green or yellow unicellular algæ, and frequently cannot do without them. In many cases aquatic animals, in leaving the sea, have entered into direct relations with the plants of the land. Thus Mr. F. W. Flattely (*Science Progress*, October, 1921), mentions a tropical species of sea-snail which has left its original marine habit a long step behind, since it occurs among grass on the top of high cliffs, or is found climbing low shrubs. There is also the well-known case of the robber crab, as it has been called, *Birgus latro*, which climbs cocoanut trees, in islands of the Pacific. Such cases, according to Mr. Flattely, present almost an exact analogy to that of the Amphibia proper.

Detractors have boggled at the idea of co-operation, pointing out that although in Symbiosis organism A may be useful to organism B, or vice versa, yet we have here only an instance of selfishness, since each thinks only of its own advantage. Yet the fact is that A and B have found it expedient and even indispensable, as the rule of life, to some extent to make the other's interest their own, and this constitutes altruism, however incipient and unconscious. Moreover, even the most orthodox of materialists have conceded that, at least in a few cases of Symbiosis, some amount of intelligence comes into play. Even if it was in the first place self-preservation, which led up to altruism, this is irrelevant as an argument against the high significance of Symbiosis. What matters is that the method of collaboration established itself successfully on our globe and that it has in fact conduced to all that is desirable and exalted in life.

Symbiosis is the ideal method of solving the economic problem of existence. It is an association in which both partners thrive, the direct antithesis to parasitism, which involves one-sided exploitation of organism by organism with ensuing impoverishment of each—a distinction which is fundamental and absolutely vital to be drawn if the problems of the web of life are to be rationally solved.

Symbiosis conduces to mutual and general enhancement of life with consequent progressive endowment of the protoplasm and a consequent urge towards progressive evolution.

These and similar high results are in accordance with the sociological principle that individuals working together in harmony as one unit produce greater results than can be produced by the same individuals working separately. This is particularly emphatic in cases of genuine co-operation. In co-operation, be it human or "natural," it matters not that the association may be, and frequently is, dictated by necessity. Nor need it be accompanied by high mentality or profound emotion. What matters is that the *modus vivendi* is such as to render the association beneficial to the participants and of general avail towards more or better life.

There is nothing sentimental in the idea of co-operation between species in Nature. Organisms do not co-operate because they love each other, but because they are dependent upon each other; because they need each other; because by co-operation they can best achieve some high and useful purpose. They can, for instance, the better overcome difficulties of existence in localities where the struggle against the elements is particularly severe. It is a fact that the Nematode Heterodera, for instance, which is a great pest to our cultivated plants, is actually symbiotic, i.e., helpful to

its food plants in the desert. And, in a general way, it is well-known that the competition between woodland and grassland ceases where desert conditions are approached. For both types have here to contend against adverse climatic conditions. It is a very general phenomenon that under conditions of stress the lessons of moderation, of restraint, and of mutual support are often more quickly and more thoroughly learned than under conditions of affluence. Again, what matters is that the lesson should be learnt and applied in the interest of progressive evolution. Organisms are like men in that they are prone to succumb to the temptations of affluence. And this makes the sociological, or at least bio-social, interpretation all the more fascinating and all the more real.

It may be recalled that the desert, with its hard conditions and its rigorous demand for integrity and for austerity of life, has so often proved, not only a source of high inspiration, but also a fountain of rejuvenation. It has been the homeland of pioneers who did yeoman service for human civilisation, much in the same way in which the lichens and other markedly symbiotic pioneers amongst lowly organisms have rendered indispensable services to what one might fitly describe as "organic civilisation"—so closely interwoven are the threads in the web of life.

Before men can duly co-operate they must be constitutionally so disposed, i.e., they must be physically and physiologically prepared for a life of restricted freedom, of self-restraint. And something similar obtains amongst organisms in Nature. Weighty considerations drawn from physics as well as from physiology, lead one to suppose that it is a constitutional law of the universe that a body should possess all that is necessary,

but no more ; that it should be purely and austerely constituted, lest it lose resistance *pari passu* with (cosmic) usefulness. Hence it is, too, that beauty is the purgation of superfluities, and, what is more, that, as Emerson says, all high beauty has a moral element in it. Emerson indeed noted that high degrees of moral sentiment control the unfavourable influence of climate and that some of our grandest examples of men and of races came from the equatorial regions—as the genius of Egypt, of India, and of Arabia.

In biology, too, we get frequently an advent of superior phases of life with the incidence of conditions otherwise unfavourable to life ; rejuvenation under abstinence, conjugation (rather than fission) with greater severity of life.

The significance is the same in either case : service-ability rather than indulgence is in accordance with the cosmic law. What is moral ? The respecting in action catholic or universal ends, says Emerson. Such an end I conceive to be service in Symbiosis, however unconscious, because it directly promotes the enhancement of life. Indeed, Symbiosis may be viewed as the source of morality, since it involves subordination to a greater whole—a subordination which even in a general way allows the good of the whole to take precedence of that of the individual good.

The Fungi, as a class, are prone, in contravention of symbiotic subordination, to indulge in parasitic excursions. Yet, occasionally some are to be met with disciplined enough to comply with a certain measure of co-operation and evincing hereditary transmission of the symbiotic disposition.

Stahl succeeded in making new species of lichens artificially by bringing the spores of a lichen-forming

fungus into contact with algal cells, with which it had never been associated in Nature. The fungus which is thus ready for co-operation is thereby apt to assist in a general way the advancement of life on our globe. For it becomes a partner in the important business of converting in a most suitable way inorganic into organic substances, which surely is a major task, a catholic end for organic life.

In Symbiosis, then, there are to be found the primordia of all integrity. Nature does not keep separate boxes for morality, for beauty, or for honour. Ruskin found that the lines of beauty and of honour are habitually on the side of restraint. And restraint is essentially a symbiotic virtue. It is not for nothing that the term "integration" commends itself to physiologists. The word has more than an etymological connection with "integrity"; and ill it fares with integration where integrity is on the wane. In reality integration is only another word for co-operation; but the latter is avoided because of its too obviously moral connotation—although, in my opinion, it would be to the greatest glory of science to establish the omnipresence of moral law.

It is usually remonstrated that good and bad are relative terms, and, hence, failing criteria, we have been satisfied to see morality pitchforked out of Nature wherever she dared so much as to show her face, although, of course, on the hypothesis of evolution, there can have been no break, no discontinuity in moral evolution.

Granted that good and evil are relative terms, could we not despite of it work with relativity so long as by so doing we achieve practical results? Is there such biological relativity? I emphatically allege that there

is. The relativity that I would stress has reference to the common good of organic life as symbolised by the harmonious relation and its exalted results between plant and animal kingdoms, as symbolised more particularly by the success of this co-evolution of plant and animal. There are values in this connection and very definite standards of " morality," or at any rate bio-morality. That behaviour, for instance, which is the most calculated to further Norm-Symbiosis and thereby the co-evolution of plant and animal is wholesome, valuable, and bio-moral ; whilst that which thwarts such co-evolution is, *per contra*, unwholesome, non-valuable and immoral.

Which is also to say that it is a primary necessity of life to obey the law of co-operation, to serve according to values and to derive all possible advantage from the principle of specialisation in division of labour. And, indeed, it can be shown that co-operation is the game that pays, whilst a life of wasteful competition is certain to end in failure. It can be shown that economic laws are eternal, and that in Nature, just as amongst men, things refuse to be mismanaged long.

We have seen that Symbiosis illustrates the application in Nature of the sociological principle that the union of individual forces engenders great advantages.

It is only in virtue of co-operation and all this entails that some lichens, composed of an alga and a fungus—two very lowly forms—are able to simulate, often to a wonderful extent, the form and partly even the structural arrangements to be met with in the green leafy shoots of higher plants. This fact is very remarkable. More than one botanist has surmised Symbiosis to contain the secret of the evolution of organic form. Weismann states in his book on Evolution ; " When at the outset of these lectures, I said that the theory of

evolution was now no longer a mere hypothesis and that its general truth could no longer be doubted by anyone acquainted with the facts available, I had in my mind, amongst other facts, especially that of Symbiosis and above all the case of the lichen."

Symbiosis involves the ordering of the metabolism in accordance with a life of service and of integrity. It means an industrious life, having to do with the elaboration of substances ideally suited for nutrition and reproduction, with the provision of that adequacy of force without which evolution could not proceed very far. It has to do, for instance, with the synthesis and exchange of starch, sugar, nitrates, proteids, in the manufacture, or part-manufacture, of which some organisms specialise more particularly than others.

We must also include in the list gases such as oxygen and carbon dioxide. The exchange of these gaseous substances is very important to organic life, and practically constitutes a nutritive exchange, too. It constitutes indeed a not inconsiderable part of the mutually complemental process, the " Norm-Symbiosis " between plant and animal. Plants and animals, as the norm of life, not only mutually complement and assist, but also determine each other in such a way as to assure wholesomeness and adequacy of evolution, which is thus practically a " co-evolution."

It has been hitherto far too little realised what cardinal issues are here involved. Dr. M. O. Forster, in his presidential address to the Chemical Section of the British Association in 1921, stated : " The wonderful power which plants exercise in building up their tissues from carbonic acid, water and nitrogen, contrasted with the powerlessness of animals to utilise these building materials until they have been assembled by plants, is

a phenomenon too fundamental and illuminating to be withheld as it now is, from all but the few."

Certainly we habitually fail to appreciate the value of the plant, be it in its capacity as bio-chemical or as bio-social agent. And we are far as yet from having elucidated the significance of the dependence of animal upon plant. In her work on the "Lichens," Miss A. Lorrain Smith points out: "The whole question of the dependence of an organism, whether animal or plant, on another, or even others, again whether animal or plant, is every day becoming of greater interest."

Seeing that Symbiosis exhibits a coalescence of sociological and physiological factors, we might appositely describe it as a socio-physiological union. In describing it thus, we transcend the narrow confines of morphology and get to grips with the real problem, which is that of an economic and physiological partnership, purporting the mutual accommodation of organisms by service rather than by theft and murder, and, in the sequel, the determination of evolution according to cosmic usefulness. We also leave behind the narrow confines of physiology, as well we might. For there is no "pure" physiology, i.e., a science of the relations of the parts, which could be interpreted exclusively in physico-chemical terms. Invariably there is an important admixture of bio-sociology. The work of the organism may be finally based upon chemical energy. But this energy is the result of symbiotic integration, and it is directed by something else which is not itself a chemical energy, and which is associated with the organic synthesis which that energy serves to maintain.

Hence physiology and sociology are eternally inseparable. Hence, also, there is need for a socio-physiological department of biology, involving a

simultaneous study of bio-social and related physiological activities together with the recognition of values in the results of these activities. Socio-physiology will bring into rational unity physiological phenomena with those appertaining to the interdependence of all forms of life. It alone is competent to deal at all comprehensively with the subject of such wide range and significance as Symbiosis. It is almost grotesque to think that biological study could be prosecuted very far without due allowance being made for the mutual relations of organisms and what these ultimately involve.

According to modern physiology, the organs of the body may be viewed as semi-independent organisms. They betray their functional independence in many ways. Pieces of a living tissue may be taken out of the body and grown in a nutritive fluid, much in the same way in which the partners composing the lichen, namely, alga and fungus, may sometimes be separated and cultivated apart. Further, in certain diseases, some parts of the body are apt to develop independently and inordinately, irrespective of the common good of the body. In so doing they tend towards the parasitic rather than the symbiotic goal of existence.

Again, it has been found that in hereditary transmission the parts behave with considerable independence. Some parts show what has been described as "dominance." Hence there is at times an irregularity of inheritance, although, as Darwin stated, non-inheritance occurs as the anomaly.

The "integration" of the organs is very close; but there is no reason to think that functionally the case differs very far from the elaborate co-operation between species in nature.

Darwin long ago admonished us that the advantage

of diversification of structure in the inhabitants of the same region is the same as that of the physiological division of labour in the organs of the same individual body.

This is saying, in other words, that the principle of reciprocal differentiation and of interdependence is the same, be it between organs or species in Nature. We have made some headway since Darwin's day in our understanding of interdependence, biological and physiological. We have come to see in a general way that the system of elaborate service of organism to organism is universal. It should not now be a far step to the recognition that the two forms of inter-action are not merely analogous but identical in principle.

Weismann contended that the lichens constituted practically single species. Here, then, physiological and biological inter-action may be seen to coalesce—an indication that the respective forms of interaction differ in degree, but not in kind. Physiology has shown that in a healthy organism hostility between tissues or organs is rare and co-operation is the Golden Rule. Lack of co-operation may mean disease, and often does. When a tissue gets " out of hand," a malignant cancer may be the result—a proof that some parts have flouted co-operation. The cancer cell is an originally co-operative cell turned parasite. It actually kills and takes the place of others.

If any part of the body, in the words of Professor (now Sir) Arthur Keith, are prone to seize more than a fair share of the manna in circulation, or to have " sticky fingers " and seize what is not really intended for local consumption, then disease inevitably ensues.

What I wish particularly to point out is that the same sequence obtains in the web of life—that disorder

and disease inevitably ensue where co-operation is flouted. The promulgation of this important truth meets with considerable difficulty. In matters of disease there is still an habitual inability or unwillingness to look the facts in the face. Sainte-Beuve foreshadowed a time "dans lequel les lois de la physiologie seront transformées en lois sociales et inaugureront dans le monde le règne de l'harmonie universelle."

But many biologists look askance at the idea of an alliance between pathology and sociology. They seem to think that as regards habits and appetites there is practically no limit to which they may be indulged in with impunity, so long as there is a *modus vivendi* of some sort—so long as the preyed upon are not altogether exterminated, for instance.

The "struggle for existence," which has never been even half understood, is thought to absolve the members of the web of life from any duties in comportment and service. Lawlessness, according to these thinkers, is the law of the web of life, in contradistinction to the perfect reign of law that is revealed by the polity of the organs. Pathology, it is true, is rather backward. But it is so precisely because organic sociality has been far too long neglected. We have not even a line of demarcation between physiological and pathological spheres. We have no valid theory, or even definition, of disease. "What is function?" "The duty, office, work, or part that is performed by an organ or tissue," says one authority. We cannot get away from duty in biology anywhere; and the concept is as essential to the understanding of the phenomena in the web of life as of those of the individual body.

Consider the definition of protoplasm, as provided by Geddes and Thomson, as that of a successful firm, which

owes its success to an unusually fortunate combination of partners—of inventive, organising, administering, pushing, competitive, and other geniuses—a firm unified from within, whether by a common purpose, or by a predominant will of its leading partners, or by something of both (the internal unity being far from being understood).

At this early stage already a good dose of well-regulated bio-sociology enters. Is it likely ever to be absent at the higher stages of life ?

If it were that chemico-physical factors alone counted, we might appropriately call the organs "integrants." Obviously, however, the term does not commend itself because it lacks sociological and socio-physiological connotation. The parts of a living whole behave more as citizens of a state than like the molecules of a substance. A better term than "integrants," one more appropriate in socio-physiology, would be "symbionts."

In a similar way the term "gamete" has approved itself in genetics as against the less significant terms sperm and germ. I submit that, instead of describing the integration of the parts of the body by such indefinite and by themselves rather puzzling expressions as "physiological economy," or "division of labour," we might, more judiciously, describe it as "internal Symbiosis."

It must be clear that Symbiosis is constituted by systematic biological co-operation, or partnership, and that the distance at which the participants carry on their partnership matters comparatively little. What matters is that the associates assist rather than hinder each other, that they maintain a co-operative reciprocal differentiation. They need not be physically attached to one another like the lichen-partners. They may be

free partners yet mutually dependent and constantly employed in the business of give and take, as instanced by the case of the flower and the bee.

Although plants are, as a rule, not attached to animals, they are, as the norm of life, in partnership with them. Many substances manufactured by plants act " physiologically" on the organisation of animals. They act most efficiently though matured at a distance. They do so in virtue of a long-standing symbiotic bond, which implies some considerable degree of awareness of each others needs, notwithstanding physical separation. Distance exists to be overcome, and it renders the partnership in many ways more significant, more valuable. There is distance to be made good between the parts of the body, too, though less than that between species in Nature. Hormones, the chemical messengers, as is now known, are the agents by which such distance is annihilated. Vitamines achieve a similar task in the Symbiosis between species, and there seems to be an important connection between Vitamines and hormones.

In Darwin's day, neither hormones nor Vitamines were known. But it was not ignored that certain organic substances have important physiological effects at a distance. Darwin felt that one of the most profound issues of physiology was here involved. Nothing in the whole circuit of physiology, he thought, could be more wonderful than the startling efficacy for work at a distance by specially matured, one might almost say, tutored substances ; and he considered that " even an imperfect answer to the questions arising in connection with this subject would be satisfactory." This is what he says :

" The various tissues of the body show, as physiologists have insisted, an affinity for special organic

substances, whether natural or foreign to the body. We see this in cells of kidney attracting urea from the blood ; in curare affecting certain nerves."

All of which has been surpassed by the discovery of Vitamines with their directive action upon animal physiology. The case of the Vitamines illustrates action at a distance to perfection. The plant alone possesses the secret of Vitamine manufacture. Vitamines owe their efficacy to " Norm-Symbiosis," i.e., the complementary relation between the " kingdoms." Nothing but the long protracted practice of partnership could explain the wonderful mutual affinity here exhibited. The symbiotic relation alone offers the training adequate to fruitful mutual specialisation both psychical and physiological. Apart from this explanation of the phenomenon, the efficacy of the Vitamines borders on the miraculous.

Darwin also stressed the " wonderful elective capacity " of male and female elements, although—the sexes frequently being separate—maturation is necessarily at a distance. He says that if there is to be hereditary transmission there has to be very specific physiological action at a distance. Even so far as the individual body is concerned, the reproductive organs are, as he says, seated in a distant part.

He attempted to account for the mechanism of such distant action in the individual body by his provisional theory of pangenesis, which, however, for various reasons failed to commend itself.

The discovery of hormones has led to a mild resuscitation of pangenesis. To-day the secretions of the endocrine glands have taken the place of Darwin's " gemmules." Hormones play an important, though still somewhat mysterious, rôle in the hereditary

mechanism. An American physiologist says: "Our knowledge of the presence and action of hormones in the blood is in its infancy. . . . We can scarcely say that the physiologist in studying the chemical harmonisers of the body, has solved the problem of individuality, or that the conception of the animal body has been rendered more simple as a result of these discoveries. . . . The chemical harmonisers in their action and in the response of the body to them are quite as baffling as the fact of harmonic action itself, so that pushing back the mystery only deepens it."

Hence it is still ignored how the organism came by its wonderful bio-chemical resources, its wonderful evolutional powers. Bio-chemistry cannot have, as is supposed by some, the last word in these questions. For it can be shown that the evolution of bio-chemical power is essentially based upon bio-chemical development, in accordance with Emerson's dictum that the law of Nature is: "Do the thing and you shall have the power; but they who do not the thing shall not have the power."

It was principally through association, with a subsequent increase of division of labour, that organisms succeeded in enhancing their bio-chemical power. According to Dr. M. O. Forster, every living plant and animal is during every moment of healthy life, a practical organic and physical chemist, conducting analytical and synthetical processes of the most complex order with imperturbable serenity.

The reservation as to the health of the natural chemist is of some importance, particularly if it should be seen that health depends upon the legitimacy of association. It is not too difficult to see that a bio-chemical specialist, whether in nature or in the laboratory,

needs the support of other reliable specialists, whose work, moreover, must bear some relation to his.

Both alga and fungus, composing the lichen, are bio-chemical experts ; but they are such largely in virtue of symbiotic association, which has enabled each to perfect special powers with consistent reference to the good of the whole and to that of organic life generally. The formation of the soredia may serve as a classical example of the way in which evolutional powers and potentialities are engendered, and become profoundly integrated within the organism by means of Symbiosis.

The partnership between alga and fungus is so profound, of such long-standing, and also of such high survival value as to cause the co-operative trait to be deeply ingrained upon each, and so as to become a feature, not only of the adult, but also of the embryonic partners, who have come to reproduce jointly. The formation of the soredia is obviously determined by the fact of a long history of partnership. The soredia are young associations of algal cells, accompanied at an early stage by a few fungal hyphæ, and they jointly go to form a new organism. The respective species have, in Emersonian parlance, " done the thing," namely co-operation, and, hence, they have the power—bio-chemical power, for instance, of reproducing themselves adequately so as to ensure the most efficient and most beneficial form of existence.

It seems curious that, in view of all this, some biologists should yet wish to describe Symbiosis as a form of parasitism. They cannot tell the grain from the chaff. They declare that the fact of the surplus products, formed as the result of the chemical life processes by an associate, and serving as sustenance to the other, constitutes parasitism. This is an arbitrary supposition based

largely upon misconceptions with regard to fundamental economics. The scientific mind is often, as Prof. J. Arthur Thomson says, almost morbidly afraid of being too generous. Co-operation is supposed by some to be a thing far too angelic to have a place in nature, where, as it is thought, the organism is the play of blind and uncontrollable forces. It is forgotten that even in the socio-political sphere co-operation obtains almost unconsciously and despite much egoism on the part of the partners who frequently think of their own profit rather than of service to the community. That symbiotic co-operation in nature is unconscious, is only parallel to the cognate process in human society where the individual trader or manufacturer hardly realises that he is co-operating in equating the balance of trade, and serving his fellows as well as himself.

The squirrel in storing nuts practises unconsciously Norm-Symbiosis, for from some of the forgotten stores new plants will in course of time germinate, and there is thus a system of co-operation between the animal and the trees so distributed. Although the storing instinct has evolved widely and independently in different classes of animals, it is not any and every animal that could come into question, for there have to be a number of symbiotic qualifications. There are all kinds of traders in Nature as among men. Some are more dependable than others. In Nature we find all gradations from perfect co-operation to the most revolting forms of one-sided exploitation, from bio-moral righteousness to bio-moral pathology.

On examination it is found that the effect of a parasitic relation upon the metabolism of an organism is totally different from that of a symbiotic relation. A parasitic animal, say a tape-worm, may adapt itself to

nitrogen instead of oxygen as a source of energy. Such an adaptation implies a totally different metabolism to that of an animal using oxygen. What is more, it means that in its whole development it becomes antithetic to the established order of things, which order has imposed on evolution a kind of orthogenesis, or, more exactly, a Symbiogenesis—direction which is such as to cause health and progress to derive their legitimacy from a reciprocal differentiation between the "kingdoms." The animal is thus rendered by the normal course of things a user of oxygen in exchange for surplus carbon dioxide, for which the user is the carbohydrate manufacturing plant.

Those partners which do not comply with this great order must suffer the penalties of disease and more or less gradual elimination. It has been said that the only eliminative processes that count in evolution are those which are discriminate and consistent. This applies with special force to what I consider to be the leading principle of evolution, namely Symbiogenesis, inasmuch as it acts with consistent reference to the good of all, and in so doing antagonises and subjects those immoderate and wasteful elements that are a perpetual danger to progress.

Emerson visualised some such principle when he declared that the league between virtue and nature engages all things to assume a hostile front to vice, and that the beautiful laws and substances of the world persecute and whip the traitor.

Parasitic organisms are obviously connected with the seamy, i.e., the pathological side of life. The micro-organisms of disease are of necessity composed of compounds, which are, stereo-chemically, antithetic to those making up the normal human body; only by means

of such antithetic or opposite characters of compounds and of ferments produced by them could such disease inducing organisms bring about their ravages. They are morbid, fastidious and dependent—the enemies of integrity, the pestilence that walketh in darkness. In the case of some bacteria, oxygen is not only dispensable but also fatal. In that of the tape-worm, it may be normal for that parasite to use nitrogen relative to its own adaptation. But relative to the established order of things it is abnormal and pathological. Infection of a rat with ova of the cat tapeworm, *Taenia crassicollis*, produces sarcoma of the liver.

Who would ascribe high survival value, or high status to a tape-worm, or a liver-fluke? Who would believe that an inheritance such as theirs is, or can be, in any way blessed?

Some biologists, at any rate, have recognised that "evolution by parasitism" shows retribution at work. Prof. J. Arthur Thomson states: "Many parasites are aesthetically repulsive in form, colour and movements, and it is interesting to contrast the attractive free stage of them with their ungraceful bloated parasitic stages. . . . The ugliness is the brand of degeneracy. . . . It is as though Nature says this asylum is open, if you will, but if you enter, you must wear the livery of dishonour."

The usual history of a parasite is this: first we get a symbiotic organism—an animal living in close and faithful partnership with the plant. Then there is abuse of co-operation, the animal proceeding to rob the plant without any counter-services. Such illegitimacy produces reactions on the part of the plant, which endeavours to protect itself against plant-assassins by poisons, thorns and other similar contrivances. Subsequently

the animal, thus excluded from the vegetable, turns blood sucker and carnivore, and in some cases becomes a rank parasite. Illustrations abound, although the full story is never told. One might mention the case of many flies which, free-living at one time, present a case of a gradually increasing adaptation to parasitism. The Myiodaria have been specially studied of late. The more primitive forms simply inhabit birds' nests, where their larvæ live on excrement or organic refuse. But some of them when adult take to sucking blood. The forms next above them in the classificatory scale show two grades of adaptation : the lower grade with the larva still living on decaying substances in the nest ; the higher grade with carnivorous larvæ which may be either occasionally blood sucking, or permanently parasitic beneath the skin.

Once there is a divorce from Symbiosis, the usual course of degeneracy is from bad to worse. Sanction after sanction is lost exactly as is the case in moral pathology amongst men. " Every sin," says Sir Thomas Browne, " the oftener it is committed, the more it acquireth in the quality of the evil."

If we had paid the attention they deserve to such subjects as interaction, compensation, correlation, status, and evolutionary physiology, such recognitions would have been made long ago. We have been content too long to use " natural selection " as a shield of ignorance, and pretended to know that nature cares solely for the good of each species—though this be a " good " that has no reference whatever to the common good of all. We have seen what wonders some lichens may achieve as pioneers and by way of simulating the structure and form of the leafy shoots of the higher plants. Such accomplishments are the very opposites of the results of a parasitic relation.

Let a plant turn parasite and it will lose, not only its woody fibre but also eventually its chlorophyll, the chief glory of the vegetable. Chlorophyll has justly been called the most precious single substance in the world.

Such a loss means *inter alia* a diminution of power—power of directing animal evolution in accordance with Symbiogenesis (co-evolution).

Mushrooms, which in their mode of life approach the parasitic goal of existence, are almost completely deficient in Vitamine A. It appears that the presence of chlorophyll is essential for the synthesis of Vitamine A. Hence degenerate plants are for the most part excluded in this important particular. Even the chlorophyll-containing plant does not synthesise Vitamine A on any and every condition. It must first be furnished with an appropriate diet—the diet appropriate to Symbiosis, as I have endeavoured to show elsewhere ("Symbiosis and the Biology of Food," *Science Progress*, October, 1921). Such a diet differs in many important particulars from that of a parasite. It is evident, therefore, that with socio-physiologically bad conditions of life we get an abnormal metabolism, one involving disease in one shape or other. It is just beginning to dawn upon us that there are also diseases of the species, notwithstanding the superstition, entertained for more than half a century, that species have been passed through a sieve in a way to make it impossible for them to harbour disease. Such an expansion of our knowledge of disease calls for a commensurate expansion of the theory of disease, and it is here, I venture to think, that socio-physiology will offer many a clue.

Although, with regard to the ultimate significance of the fact that oxygen rather than nitrogen offers the

desirable source of energy, our chemists and physicists may have much to say, there will always be importantly connected with these questions a socio-physiological issue. For the associative factor is ever there. On the philosophical side we may conclude that duty is not confined to men nor to parts of the individual body. Duty is equally indispensable throughout the web of life. It is a universal requisite in view of the bias of the universe for a definite order in all things. This view is in harmony with the philosophical conception of the good as equivalent with the rational, a conception which postulates a universal moral order independent of any particular conditions and binding upon all participants.

It may be of some little interest in this connection to refer to an adumbration of the socio-physiological theory of disease as put forward by Dr. John M. Clarke. In his book *Organic Dependence and Disease,* he argues that disease entered the world with the rise of dependent races of animals. These attach themselves to the free-living animals, allowing these to do some of the work of getting a living for them and thus perturb the normal activities of the free-livers and produce disease. The dependent creature, according to this writer, is also living an abnormal life. He believes that in the very earliest forms of life there were no dependents ; all were free. But gradually certain forms acquired the habit of living at the expense of other organisms.

This theory, then, may be said to be a tentative recognition of the pathology of parasitism. It alludes to the bio-social factor but fails to cement it with the physiological. We can see the *facilis descensus,* but we cannot see what it is that, in normal days, saves the organism from itself, as it were, that keeps it from perilous lapses and to the path of integrity.

Unfortunately the whole development of biology may be said to have been inauspicious to a fair view of Symbiosis. When the pioneers of modern physiology wished to illustrate the functional independence of the elements of the body by examples drawn from the sociality of Nature, they were handicapped by the backwardness of biology, which knew not Symbiosis but did know parasitism—although only superficially, i.e., merely morphologically. Hence they backed the wrong horse and explained co-operation in terms of parasitism. Darwin stated in support of his hypothesis of pangenesis :

" Physiologists agree that the whole organism consists of a multitude of elemental parts which are to a large extent independent of one another. Each organ, says Claude Bernard, has its proper life, its autonomy ; it can develop and reproduce itself independently of the adjoining tissues. A great German authority, Virchow, asserts still more emphatically that each system consists of an enormous mass of minute centres of action. . . . Every element has its own special action, and even though it derive its stimulus to activity from other parts, yet alone affects the actual performance of duties. . . . every single epithelial and muscular fibre-cell leads a sort of parasitical existence in relation to the rest of the body."

Of course Darwin did not mean to say that the parts are parasitic in the functional sense of the word, but only in the superficial sense, the formal sense. Actually he wished to say that they are symbiotic, save that Symbiosis was not then known. But the mischief was done, and the error persisted.

Manifestly, if all cells are " parasitical " upon each other, whilst they are yet, as we are told almost in the

same breath, performing their duties to the whole, there is a contradiction somewhere, and we come perilously near mistaking the shadow of parasitism for the substance of co-operation.

The merest contemplation of the stupendous amount of dutiful co-operation required from the parts on Darwin's hypothesis, should be enough to dispel the charge of parasitism. There is a host of " nicely balanced affinities " required, according to " pangenesis." How could we have these in a progressive sense in the absence of co-operation ?

How could the reproductive organs perform the " high functions " imputed to them by Darwin, if they or their associates were tainted by parasitism ?

Here are the duties, which Darwin assigns to the reproductive organs, together with their accessory parts : " to adapt one or both (sexual) elements for independent temporary existence, and for mutual union."

This is adapting them for partnership and not for mutual plunder. A parasitic association produces chaos, as was well shown by the case of the hermit crab, infected by Sacculina, where parasitism was seen to have disastrous effects upon sex. Or need one allude to what has been well called the nemesis of reproduction in parasitism, or to its pronounced liability to hyper-parasitism ?

Darwin argues that it appears natural that gemmules derived from reduced and useless parts would be more liable to perish than those derived from other parts which are still in full functional activity. But similarly in the web of life, comparative uselessness renders an organism liable to disease and extinction ; and it is eternally true what Ruskin said, that " to be valuable is to avail towards life. A truly valuable thing is that which leads to life with its whole strength. In

proportion as it does not lead to life, or as its strength is broken, it is less valuable ; in proportion as it leads away from life, it is unvaluable or malignant."

The usual effects of use and disuse appear as very "natural" to one who has come across them on every hand ; but they are really plausible only with a due socio-physiological interpretation. Meanwhile it is evident that as regards the attribution of parasitism to the functional independence of the parts of the body, zoologists have accepted too uncritically the verdict of physiologists, which was not at all a profound, but a superficial one. Physiologists, as a rule, are wont to dig deeper than zoologists and botanists. None the less the latter should not entirely efface themselves, but should on occasion insist on their better knowledge.

Just as attachment of participants has been mistaken as the sole physical criterion of parasitism, so, on the bio-social side, dependence *per se* has been mistaken as constituting a parasitic relation. As though there were organisms which are not dependent ! As though there were not all degrees of dependence, good and bad !

Weismann recognised that parasitism differs from Symbiosis in at least one respect, inasmuch as in parasitism a species is simply preyed upon by another without receiving any benefit from it in return, whilst Symbiosis presents a case of partnership where each of the two species affords some advantage to the other, and makes existence easier for it.

Yet he was perplexed with regard to dependence. He argued that fungi, for instance, since they are dependent on other plants for their food, must necessarily be parasitic, which is contradicted by the fact, stressed by himself, that there are fungi so greatly inclined to Symbiosis that they can be artificially induced

to enter into symbiotic union with foreign algæ. He says that fungi must associate themselves "in some way" with plants living or dead, and he is unable to draw any distinction as to the way in which it is done. In a few cases they may destroy the plant they associate with, in others they may render some return service. Weismann thinks it makes little difference, one way or another. But there is a world of difference. For one way of dependence marks pathology and the other physiology.

Consider what fungi are capable of by way of rendering services in return for some few spare products of the plant. According to Weismann's own account, fungi generally have the power of discovering and absorbing the least trace of water in the soil and with it they absorb the salts necessary to the plant. They are thus able to render great services even to large plants fixed deep in the earth. Many of our forest trees, e.g., beech, oak, fir, silver poplar and some bushes (broom, heaths, and rhododendrons) are thickly wrapped round with a net of fungoid threads—a case of Symbiosis. The plants give to the fungi some amount of the superfluity of their food-substances, and receive in return water and salts, which are of value especially in times of drought. Perhaps there is some connection between this and the fact that limes wither and lose their leaves so quickly during great summer heat; these and many others of our trees, possess no root-fungi or mycorhiza.

The view that dependence of organism upon organism for food constitutes parasitism would cause all organisms to be classed as parasites, as they are in one way or another dependent upon one another. Dependence *per se* is not at all a fault. Illegitimate dependence alone imparts the taint, as will be seen more fully in what follows.

If Symbiosis were no more than a kind of parasitism —" a not very one-sided parasitism," as is sometimes declared—why coin a special term for it? Why this redundancy when biological terminology is already over-burdened with technical expressions? Is health merely a one-sided form of disease?

According to modern physiology, the polity of the parts in the body is ruled by the " law of the members." This law surely does not square with the idea of parasitism, which is precisely the antithesis to such integration!

I have been taken to task for the statement that with regard to the distinction between parasitism and Symbiosis science has not yet attained clarity of thought. I emphatically reiterate this statement, and I would add that as the result of the lack of discrimination, superficial resemblances have come to disguise essential differences. Only dubious cases of co-operation have thus come to be admitted as Symbiosis, whilst the good cases of partnership have been ruled out or treated as non-existent.

The fact that symbiotic partners must be of high integrity—as befits a good and elevated form of partnership—that Symbiosis only pays when the game is played fairly, has been construed as signifying that Symbiosis is inferior and incompatible with freedom. In truth it is merely incompatible with licence, with theft and murder. It cannot be a matter for surprise, in view of the frailty of life, to find that in symbiotic relations, normally healthy, there is always the possibility of a partner playing traitor, by taking undue advantage of his favourable situation.

But the fact that such a course, if persisted in, inevitably leads to disease and degeneration—as was instanced in the citation from Prof. Arthur Keith with

reference to internal Symbiosis—is ample evidence that integrity alone avails towards fuller life. The thief steals from himself. The symbiont which fails in its duty, in the end penalises itself. "He that will not work, neither shall he eat." That is not merely the word of the Apostle; it is the law of Nature.

All of which has hitherto been far too little realised, with the result that co-operation, which is easily the most fundamental and the most all-pervading principle of life, has actually come to be contemned and even repudiated by biologists. We live in the midst of Nature and know her not. We stumbled across the negative factors of evolution before we recognised the positive; we builded on the phenomena of disease rather than upon those of health; we argued from artificial and mostly pathological processes as to the norm of Nature; from the lesser and inferior as to the larger and superior; from abuse as to use. We took greater interest in law-breaking than in law-abiding organisms. We knew the deadliness of the alkaloid poisons before we realised the beneficence of the Vitamines. We praised competition before we appreciated co-operation, and warfare before industry.

In *Nature*, April 29th, 1922, Prof. F. W. Gamble asserts that Symbiosis is at best a secondary phenomenon of the struggle for subsistence. He alleges that it is not even a safe compromise, that co-operation may mean litigation, that mutual benefit gives place only too easily to one-sided benefit or to mutual harm. The symbiont, according to him, becomes a parasite. Requiring such a delicately adjusted balance, he argues, Symbiosis can never have been an evolutional factor of real and widespread significance.

The question is whether the web of life does not amount to a veritable "organic civilisation." If it does,

as I assert it to do, then we get something similar to the case of human civilisation, which achieves its greatest power precisely through restriction of individual liberty. Civilisation involves, according to Emerson, the evolution of a highly organised man, brought to supreme delicacy of sentiment, as in practical power, religious liberty, sense of honour, and taste. Of the English, he says that they choose that welfare which is compatible with the commonwealth, knowing that such alone is stable. Yet, as he declares, they have more personal power than other people.

Is there not status with commensurate degrees of duties and obligations amongst organisms too? There is every reason to think that there is, and further that restraint has been the universal law of progress. If it were thinkable that the species lion could hold a council to discuss their chances of survival, of reform, and of reconversion, one might expect a specially ferocious and intransigeant leonine councillor to use such argument as that of Prof. Gamble's in defeat of any "soft" talk of co-operation and reform, notwithstanding Darwin's view that a carnivorous beast may improve its chances of survival by becoming less carnivorous. One might think, on reading Prof. Gamble's remarks that a life requiring and exhibiting balance is inferior to one not so excelling. Evidently, Prof. Gamble is taking a mere specialist view of Symbiosis, limiting it to physical attachment of the partners, i.e., to primitive, exotic and unstable forms of co-operation. There is an abundance of perfectly stable and exquisite cases of Symbiosis in Nature, and they go to show that, contrary to Prof. Gamble's view, co-operation has been the most important principle throughout evolution.

Prof. Gamble confesses that the facts of biology are imperfectly known and still more imperfectly apprehended in their full significance. And how could it be otherwise, seeing that the study of interaction, of organic sociality, has been neglected hitherto, seeing that it has been woefully ignored that there is a normal dependence of organism upon organism, such as that between plant and animal, for instance, involving ultimately nutrition, respiration, growth and evolution? Surely it will not do to slur over or deny this important inter-dependence merely because we have as yet no formula for it, no system of biological thought in which it could find a due place.

Prof. Gamble would fain quash all claims of Symbiosis as an evolutionary factor, on the ground that, as he avers, living organisms must stand in general on their own ground. Does he mean to say that organisms must be free from all dependence, even that of Norm-Symbiosis? Does he wish to suggest that every organism should be in a position to say to another: I have no need of thee, nor any duties or responsibilities in organic interdependence? If he should demur, perhaps he would be good enough to refer us to the text book of biology in which these duties and responsibilities are clearly delineated. Biologists have been able to gather prestige without troubling about interaction. It may be said with a measure of truth that they have succeeded precisely because they have slurred over these important matters. For great is the lure of irresponsibility, and there are many at all times desirous of being absolved, on any pretext whatever, from that self-control and personal responsibility upon which all civilisation in the last issue rests. Meanwhile biology cries aloud for an understanding of interaction.

When the " Psychology of Science " is fully written some day, it will be seen that Darwinism, with its doctrine of mere expediency, has much to answer for in present-day degeneracy. The astonishing thing is that, as the *Times* stated on September 23rd, 1922, so many modern thinkers, or, perhaps, half-thinkers, do not appear to object to the idea of natural selection.

All wholesome evolution requires control, and this is most ideally and most effectively supplied in Nature by the institution of Symbiosis with its socio-physiological momenta.

The ordinary course of evolution in Symbiosis is from attached to intermittent partnership, i.e., from a narrow and quasi hermaphroditic to a freer and quasi unisexual form of co-operation. Such evolution implies a progress in desirable specialisation, in division of labour, in capacity for organic civilisation, with manifold commensurate physical and psychical powers. It is the obverse of, and antithetic to, evolution by parasitism.

My thesis has long been that Nature abhors parasitism just as it does perpetual self-fertilisation. Both are unavailing for progress. By innumerable and immemorial experiences the plants have learnt that cross-fertilisation is preferable to self-fertilisation. They would seem to have realised that comparative self-sufficiency is deleterious, and that the organism, in order to be successful, must be widely related, widely supported, and widely useful. Which is also saying that the organism must be somehow controlled and determined according to advancing values, according to the advancing march of co-evolution between plant and animal life.

The plant is still the great hieroglyph to us, and we can only dimly gauge its intelligence. We know now, however, that mental processes, sometimes of a

complicated nature, and sometimes of a great moment, go on within ourselves, and it is only too likely that some such unconscious psychogenesis occurs also in the plant, and, what is more, that intelligence exists distributively as between animals and plants, and that psychic processes in general are fostered in an auspicious manner by Symbiosis.

Evidently, the plants have made great sacrifices to attain cross-fertilisation, as though they were eager to avoid self-sufficiency by all means in their power. Of course they have gained by sacrificing the lower mode of propagation for the higher. But it is also certain that this gain in one important direction was purchased by limitations in others, tantamount to increased bio-social control. Cross-fertilisation meant reliance upon animal agency rather than upon weather and wind, i.e., on civilisatory rather than upon inanimate factors, on a social rather than a non-social nexus. It meant increased dependence on co-operation, with the requisite degrees of discipline, to all concerned.

The plants have actually to some extent adapted themselves to hermaphroditism, in order to function the better in Norm-Symbiosis—so greatly are sub-ordination and control the rule in the web of life. In order to obtain insect aid in fertilisation two ways were open. The female blossom, as well as the male, might offer something attractive to the insects, or hermaphrodite flowers might be formed. Both ways have been followed. An example of the former is the willow, the cross-fertilisation of which, as Weismann says, was forced upon the insects by the development in both female and male blossoms of a nectary so that the insects are attracted to the separate sexes of the willow and thus effect cross-fertilisation.

The securing of cross-fertilisation by the development of hermaphrodite flowers has been the more frequent way of solving the problem. This method secured the advantageous crossing much more perfectly, for the pollen had necessarily to be carried from blossom to blossom, whilst, in cases like that of the willow, innumerable male blossoms might be visited for nectar, one after another, before the insect made up its mind to fly to a female blossom of the same species.

In adapting itself thus to cross-fertilisation, the plant is not reverting to self-fertilisation, which, as is well known, is generally avoided despite the proximity of the sexes. But it is evident that the plant is subordinating its "physiological economy" to the interests of Norm-Symbiosis, i.e., of co-evolution, and this is an important witness to the reign of law, of the great significance of Symbiosis, in the web of life. Let us take a case of Norm-Symbiosis with intermittent attachment still very pronounced. The large white flowers of the Yucca plant are fertilised by a small moth, *Pronuba Yuccasella*. The female moth collects a large ball of pollen. To this end she has on the maxillary palps a long process, curved in the form of a sickle, and covered with hairs, with the help of which the moth very quickly sweeps together a ball of pollen. With this ball the insect flies to the next flower, and there she lays her egg by means of an ovipostor in the pods of the flower. She then pushes the ball of pollen deep in the funnel-shaped stigmatic opening of the pistil and so effects the cross-fertilisation. The ovules develop, and when the caterpillars emerge from the egg four or five days later they feed on these until they are ready to enter on the pupa stage. Each small caterpillar requires about eighteen or twenty seeds for its nourishment.

The sickle-like process of the Yucca-moth has not so far been found amongst other Lepidoptera, and the organ has therefore come to be regarded as typifying the emergence of new characters incidental upon Symbiosis. But it is only a fractional instance of what Symbiosis is capable of in the way of morphogenesis. The proboscis of the Lepidoptera depends entirely upon adaptation to honey-sucking, which, in this case, is an adaptation to Symbiosis. Weismann states that the order of Lepidoptera would not exist if there were no flowers, which is saying that the emergence of the order was due to Symbiosis. According to him, this large and diverse insect-group is probably descended from the ancestors of the modern caddis-flies, or Phryganidæ, whose weakly jaws were chiefly used for licking up the sugary juices of plants. That is to say, again, they go back to symbiotic animals. And in general it is only from a "non-specialised," cross-feeding animal ancestry, i.e., from one living symbiotically on the spare products of the plant, that we can expect long lines of descendants.

Whilst animal evolution is thus seen to be largely determined by the plant, the evolution of the latter is in turn largely determined by the evolution of the animal. Weismann says that the existence of gaily coloured, diversely formed and fragrant flowers is due to the visits of insects.

I have endeavoured to show elsewhere that the habit of plant-murder on the part of herbivores constitutes a serious divorce from Symbiosis, that it frequently leads to "over-specialisation," such as the over-development of the jaw and its associated parts, similar to the case of rank carnivores, and in either case with fatal consequences upon evolution. "Over-specialisation" thus invariably emerges as specialisation

to predacity in one form or another, and the inexorableness of bio-moral law is demonstrated by the universal failure of such specialisation.

The "non-specialised" is the non-aggressive organism, which maintains a tolerable relation of Norm-Symbiosis. In the primates, the development of grasping lips and a long series of grasping teeth has been rendered unnecessary by the food grasping power of the primate hand. And the food that this famous hand did grasp pre-eminently during long ages of control and discipline was that appropriate to Symbiosis : the kindly fruits of the earth.

The mammalia as a class are notoriously fond of nuts and berries, and they have all along been the natural partners of the respective trees, the distribution of which they assisted much in the same way as ants and other insects or birds aided that of their food plants.

It has recently been found that nut proteins are of very high dietary value in virtue of the high proportion of hexone bases which they contain. Particularly good effects have been obtained, according to Mr. R. H. A. Plimmer (*Journal Soc. Chem., Ind.*, 1921) with cocoanuts, walnuts, filberts, pine and other nuts, and Mr. Plimmer stated in this connection that experimental work has thus confirmed the assertions of fruitarians of the high value of nuts in nutrition.

When we reflect moreover that seeds are the best sources of Vitamines, and as such are every day becoming more significant, that the endosperm is often wonderfully endowed with good qualities by the plant, we may infer that Symbiosis involves, among other benefits, a crop of psychic advantages.

Prof. R. Ruggles Gates has pointed out that the evolution of the seed is the final stage in the production of structures to protect the young embryo, and that in

this sense seed-bearing plants correspond to the mammals, in which the maximum protection to the developing embryo is afforded. Evidently the plants have forestalled the mammalia in much that we consider specially exalted in their lives, such as the high development of parental relations, which are held to be the glory of mammalian life. May we not believe that the animal is to a large extent inspired by plant influences? In any case there is good reason to think that the nexus between plant and animal is very profound and very significant. The extension of the idea of co-evolution to psychic development lends colour to the philosophic belief that the mind of man is of the same stuff as that of the universe, or, as Emerson expressed it, that one and the same law runs through Nature and the mind of man.

Our knowledge of the physiology and genetics of trees, says Prof. Keeble, is at present far from perfect. However, he tells us that a tree "looks before and after," and it may well be that the study of the psychology of trees may become one of the most fascinating of sciences.

Now to revert to the Yucca moth. The eggs, which the female lays in the seed-pods, are very few, and the caterpillars emerging from them eat a very small proportion of the seeds, of which there may be about 200. Owing to the symbiotic moderation thus exhibited by the insect, enough seeds are left, and the plant therefore has great advantages from the association. The form and position of the stamens and of the stigma seem to be as exactly adapted to the visits of the moth as the moth is to the transference of the pollen. The Yucca can only be fertilised by this moth, and sets no seed if the moth is absent. Although here the mutual dependence is very great, yet the partners do not seem to be unduly cramped in their freedom, and the case shows that we can have

Symbiosis without constant attachment and without one-sided exploitation. From interaction such as this the happiest results in evolution may justly be expected.

It is usually overlooked that numbers of insects excel in symbiotic moderation. One usually finds their successes attributed to their "shock-tactics," i.e., the excessive multiplications by which they are supposed to overcome most of their difficulties.

But it can be shown with much more justice that their astounding evolutionary success is in the first place due to their high specialisation in Symbiosis and to their symbiotic moderation in nutrition and multiplication. There is the case of an Australian saw-fly, an hymenopterous insect, which, like the Yucca moth, exhibits symbiotic moderation in its demands on the partnering plant. As a result it is able to survive for a considerable time the period of egg-laying, which in innumerable other cases seals the fate of the mother insect, precluding it from any extended solicitude for the next generation. The female saw-fly saws clefts in the leaf and therein deposits her eggs—although usually only one is passed into each slit. On the leaves the mother sits until the exclusion of the larvæ, and as soon as these are hatched, the parent follows them, sitting with outstretched legs over her brood, protecting them from the attacks of parasites and other enemies with remarkable perseverance.

So in the case of the Longicorn beetles, many of which show exceeding moderation both as regards nutrition and reproduction, as a result of which they enjoy great longevity.

Everywhere restraint and control are the Golden Rule of life, and everywhere it is Norm-Symbiosis that provides the standards of behaviour. Exceptions only confirm the rule. They come under the heading of abuse.

Just as there is a number of carnivorous plants, which antagonise Norm-Symbiosis, by securing only a portion of their nutritive material by the usual method of assimilation, and gain another portion by dissolving and utilising animal protein—an arrangement very divergent from the ordinary disposition of plants, as Weismann says—so there are plants which apparently subordinate Norm-Symbiosis to what one might call " Luxury-Symbiosis."

In the former class we have the insect-catching sundews, the nepenthes, and the toothwort; in the latter the orchids. All of these tend to approach the parasitic goal of life, which means decline and retrogression. The sickly little sun-dew of our bogs has little to boast of. It has the feeblest possible roots and little power of resistance. In this it is similar to parasitic plants such as the dodder, the butterwort, and the yellow rattle, which show poverty of roots and wither quickly when taken out of the ground.

The orchids, rather than specialise in Norm-Symbiosis, have consorted with certain types of fungi, which they harbour in their roots, but which may extend further through their system. The species, so allied, have in common a dietary interest in dead or decaying organic matter. Neither is given to work in pioneer fashion. It is not so much a yearning for honest synthetic industry that is at the bottom of the association, as a joint craving for saprophytism—for " in-feeding." Birds of a feather flock together. Many higher plants, as we have seen, employ fungi, but in this case the employees are strictly controlled as paid servants. In the case of the orchids, however, the fungi have obtained an undue importance. They have almost become the masters, and the result is that the orchids have little

co-operative energy to spare for Symbiosis with animals. Luxury-Symbiosis has detracted from Norm-Symbiosis. Some orchids, as is well known, have recourse to subterfuge in order to contrive fertilisation by insect agency. Often it is only the lowest class of insects that feel attracted by orchids at all. The frequently gorgeous appearance of the orchids, therefore, offers no compensation for the absence of serviceability. The orchids cannot serve progress and luxury at one and the same time. The fungi take the lion's share of what carbohydrate surpluses there are, and they have thus come (retrogressively, from the point of view of organic civilisation) to occupy the place which is usually more felicitously held by insects in the life of plants.

Just as anemophilous (wind-fertilised) plants, relying upon comparatively low help, are inferior in status to entomophilous (insect-fertilised) plants, relying on civilisatory means, so plants with low organic associations are inferior to those with higher associations. The difference in status is frequently marked by a difference of metabolism, and this often to so marked a degree as to cause a serious antagonism, a clash of interests, to arise.

The case of hay-fever, which is caused by the poisonous effects exerted by the pollen of wind-fertilised weeds, shows that a badly associated plant is apt to become a menace to the aristocracy of life. The reason is that the mode of development of the wind-fertilised plants may bear far too little relation to the established symbiotic dispensation of things, to that relativity which alone is in accordance with the spirit of the times—the right that is born with us, as Goethe put it. Differences in the discharge of fundamental duties must in the end result in physiological disharmony, too.

Weeds are apt to poison, not only men and animals, but also other, more useful, plants. The ill-regulated metabolism of such weeds lends itself to pathological action—the difference is, eternally, between the good and the bad. Hence, too, man, as the conscious partner of the useful plant, has to wage incessant warfare against unregenerate weeds.

A little reflection will show that any serious divorce from Norm-Symbiosis on the part of a plant, is apt to impair the normal exchange relations in the world of life, and, hence, to react unfavourably upon the plant's own metabolism, its own fate.

The orchids are an example. Despite an enormous seed-production, despite innumerable contrivances to secure cross-fertilisation, they are very sparsely distributed in Nature. Darwin sagaciously suggested that perhaps the orchids fail to give satisfaction to the insects—an adumbration of deficiency in Norm-Symbiosis.

In point of general serviceability, the orchids have but the poorest record. They yield few substances of any value, which in my view is an important symptom of backwardness, for it is recognised, at least by some botanists, that the status of a plant is in proportion to its output of useful organic substances. Often they present a moribund appearance, and they are narrowly dependent on epiphytism and saprophytism. Their life is precarious in many ways. They have undoubtedly achieved some degree of autonomy, compared to the better controlled life of other plants. But the achievement was at the expense of status and of evolution.

In their craving for licence and for " in-feeding," the orchids compare favourably with cancer-cells, which, in the individual body, similarly seek an anti-social autonomy of their own. Be it in physiology, or in biology,

anti-social behaviour is the cause of disease. The lesson is so thoroughly worth learning, that we may well pause for a moment for some further physiological considerations.

Modern physiology tends increasingly to the view that normal growth of tissue cells is only possible under the "control" of other cells. In *Nature*, January 12th, 1922, Prof. W. B. Bayliss states that "the loss of differentiation in the growth of tissues *in vitro*, except in the proximity of another tissue, no doubt indicates some kind of influence by one tissue on another. But the fact that this influence disappears when the new cells wander away into the culture fluid is difficult to reconcile with a chemical product."

We may conclude that it is primarily the fact of partnership that constitutes the "co-ordinating" influence, the chemical control being subordinate to the socio-physiological. When the lichen-partners are separated and cultivated apart, the habit of growth is different from that which occurs when they associate to form a lichen. It is the associative factor that makes the difference in the web of life as in the individual body. A loosening or lowering of the association is apt, according to circumstances, to produce deterioration, reversion, disharmony.

It was found in the case of a particular tumour, which was only in part malignant, that when a culture was made of the epithelium of the normal parts of the cells, deprived of the influence of their surrounding tissues, these parts give rise to daughter cells similar to those of the malignant growth.

How are we to explain the behaviour of this epithelium? We must consider the epithelium as suspect, since it emanates from a tumour, i.e., an essentially

pathological formation, malignant or not. We are entitled to conjecture that the parts from which the epithelium was taken, although normal in appearance, have yet been for some time affected by morbid influences obtaining in the immediate neighbourhood. Although not yet entirely moribund to ordinary vision, they have yet had imparted to them a considerable measure of predisposition to cancer, a bias to anti-social development. Given a serious deterioration of the general metabolism, as is implied by a disease such as cancer, making itself felt more particularly in the organ from which the tumour sprang, it is only a question of time when the partly affected tumour regions will fall victims to the ever-increasing temptation to rank parasitism. Such a fall, although it mean a merry albeit a short life to the individual cells concerned, involves malignancy *vis à vis* to the body.

To some extent, of course, the phenomenon is a case of *sauve qui peut* and of *chacun pour soi*, for, under the prevailing stimulations, the organism must go down hill, and the socio-physiological bonds must inevitably snap asunder, threatening general anarchy. That is indeed the significance of the appearance of the tumour : the central government has become weakened, and local anarchy has been set up instead. It is pleasing to think that would-be profligate cells may be held in check for a long time by the constraining effects of what good influences are still extant in the Sodom of a body and the Gomorrah of an organ. It shows that Nature is long-suffering and thoroughly trustworthy. And there is even more implied in this beneficence. Removal of the epithelium from the body in this case means withdrawal of the last remaining symbiotic influences, an utter divorce from Symbiosis. Hence the severance means the

final demoralisation of the tissue. To restore to functional independence a tissue of this kind is a daring experiment, the result of which must depend on the conditions prevailing before and after the experiment. The operation in itself, we may assume, severs many subtle threads ; and of these the symbiotic ones can least be spared. It is intelligible, therefore, that an operation of this kind may facilitate the transition to parasitic licence, in a case where cancerous proliferation has previously been but one remove away.

It has been truly said that *malus malum vult ut sit sui similis*. And this applies also to the case of the cancer cells, although the influence be not always clearly demonstrable. But what do we know of predisposition, of the inceptional stages of disease, of its early causes and symptoms ? " We are indeed in some doubt with regard to certain fundamental facts," says Prof. (now Sir) William Bayliss on another occasion.

An old medical maxim runs : *pathologia physiologiam illustrat*, and from the study of cancer we should be able to glean not a few lessons of health. From what has so far been said we may conclude that there are in operation in normal days many symbiotic momenta, tending to preserve the parts in the path of integrity. The good parts control the bad with quasi moral power—the true dominance in Nature as amongst men. So, in the more purely biological sphere, the presence of symbiotic systems, making for increased economy and increased security of life, tends to raise the level of organic life much in the same way as the presence of a thrifty class of citizens, or of an aristocracy, tends to raise the level of the socio-political life.

Seeing that organs and organisms are involved in a common sociality, are jointly and severally under a basic

law of concord, our business should be to learn more about co-operation, and in particular about Symbiosis, as the antithesis to disease. We should not shrink from the recognition that in a case of cancer there is a loss of integrity on the part of the organism, if not of the species, and that hence the whole comportment of the organism as a responsible member of the web of life has to come under critical examination.

"Wie die Alten sungen, so zwitchern auch die Jungen." We cannot get away from the hard fact that the cancer-cell is an anti-social, parasitical cell, and that the inference is unavoidable that the organism which harbours it, has itself partly become deficient in integrity, has indeed itself begun that divorce from Symbiosis, which, as an evil communication, translates itself to the parts.

Unfortunately we are little accustomed to look the immutable facts of disease honestly in the face. We are all practising deceptions upon ourselves, postponing the consequence of our misdeeds until they culminate some day in cancer. We run an account with retribution, as Henry Drummond used to say ; we delay the reckoning time with God. But every day is a reckoning day, and the sin of yesterday, as part of its penalty, has the sin of to-day. We cannot cheat Nature.

> I looked behind to find my past
> And lo, it had gone before.

So Plato : "A transgression easily steals in imperceptibly and by way of diversion and apparently without producing mischief we are becoming familiar by degrees with the evil. It insensibly runs into the manners and pursuits, and from thence in intercourse of dealings one with another, it becomes larger ; and from this

intercourse it enters into laws and policies with much impudence, till at last it overturns all things, both private and public."

Plato was endowed with profound insight into moral and physical pathology, and the above passage contains an apposite warning even to modern nations to set their house in order on the physiological side, lest demoralisation affect the whole level of life.

Cancerous tissue for some time retains the mode of growth of the healthy organ from which it sprang, which shows that there is usually a condominium of good and evil influences, although the one or the other may obtain the mastery.

Cancer has sometimes been explained as due to a subversion of the " ordinary " (though mysterious) laws governing the proper relations of tissue growth.

Again, it must be said that much would be gained if we took the view that the disease is primarily due to failing co-operation with consequential failure of support, and, hence, failure of strength and of resistance. A tissue with a craving for licence is not one inclined to co-operation. It is a spoiled child. Because of its unreadiness to co-operate with others, it is in turn left unsupported by them. Tumours are imperfectly provided with blood-vessels, which confirms the socio-pathological view here set forth. No community in the world can afford to support idlers and anarchists long. Every organ has to be adapted to the requirements of the body as a whole and not merely to its own selfish ends, and it is the same with the organism in its relation to the organic family as a whole. Hence licentiousness has everywhere to be penalised, and it is in fact true what Emerson stated, that the league between virtue and nature engages all things to assume a hostile front to

vice, and that what we call retribution is the universal necessity by which the whole appears wherever a part appears.

In cancer-cells mytosis is defective. In general it is the nobler parts of the cell that suffer diminution in cancer. So a parasitic organism incurs losses of the nobler parts. It lives and multiplies at the expense of individuality and status. The loss of noble parts merely corresponds to the failure of noble function, i.e., social function. Again, as Emerson says : " He is base—and that is the one base thing in the universe—to receive favours and render none."

The cancer cell is one that assumes an embryonic type. It presents a case of reversion—reversion to a state of comparative barbarism with its comparative unrestraint. It is as though the respective cells would fain recover the licence of more primitive times before they had formed intricate relations with other cells and tissues. Such backsliding, however, is incompatible with the existing dispensation, both biological and socio-physiological, which requires the organism to be attuned to a highly developed system of duties, in keeping with the advanced state of organic civilisation. In its assumption of the embryonic type, the cancer-cell makes use of a certain innate power of asexual reproduction, which is present chiefly amongst the lower forms of life, although the higher forms have largely surrendered it in favour of more widely useful arrangements. In progressive evolution the due sexual form of reproduction is striven for.

The view is gaining ground that undue stimulation, chiefly dietary, is the cause of cancer. This seems roughly correct, but, more explicitly, we might attribute the incidence to non-symbiotic stimulation. This would include the ill-effects of bad feeding habits, whilst

at the same time stressing the correlated phenomenon of the severance of allegiance on the part of cells and tissues, which is so marked a feature of the disease.

Without a doubt we have hitherto under-estimated the rôle of food, both in integration and disintegration, in normal and in abnormal, or suicidal, evolution. It may here be recalled that where we get colony formation—a kind of integration—e.g., amongst algæ (Chlamydomonas), the first step towards complexity of organisation depends upon the supply of appropriate nutritive media, and it is particularly important to note that it is mineral salts which are required—that food, provided with which the plant is able to excel in symbiotic service, in the performance of its noblest functions, such as the direction of evolution in accordance with cosmic ends.

Ex quovis ligno non fit Mercurius.

The food, appropriate to Symbiosis, is pre-eminently suited to high specialisation with the requisite socialisation of the parts. Food not so appropriate, is apt to thwart developments in many directions. Nothing, indeed, could be better calculated to open one's vision to the significance of suicidal tendencies in life than a study of the biology of food. Here, in the nutritional field, is the door through which, in Plato's words, transgression insensibly steals in. Here we get cumulative effects of great magnitude, which, indeed, as I have been at some pains to show in my book on *Symbiosis: a Socio-Physiological Study of Evolution*, may be said to constitute by far the greatest part of evolutional pathology.

Let us take a few examples typifying how evil communications are everywhere introduced by the medium of food—food that is inappropriate to Symbiosis. They will show where malignancy such as that culminating in cancer really begins.

There is a well-marked transition in unsymbiotic feeding, which leads from plant-murder to carnivorism, and from this to cannibalism. The gradation is attended by a corresponding deterioration of character.

Carnivores in the end become so callous that frequently the feline mother has great pains to save the young from being devoured by the father.

The young birds of prey—*lascivi soboles gregis*—do not hesitate on occasion to devour their weaker brethren and sisters. Mr. Oliver G. Pike, F.Z.S., F.R.P.S., reports from his observations of young buzzards: "When the parents are absent for a long time from the nest the young become restless; they also become very hungry. Without any warning the two stronger of the young buzzards set upon their weaker nest companion, and it is not long before it is killed and devoured.

"Once, having tried cannibalism, the two remaining birds fight. What actually happened in one nest, however, could hardly be called a fight, for it was too one-sided. The two birds were walking around their home, looking for any trifles of food that might have remained, when the more powerful of the two pounced on to the back of its companion, and rained down blows with its hooked beak upon the head of its captive, soon stunning it. A few moments later it was standing on the lifeless body, pulling off and devouring tender morsels. Later, when one of the parents returned with a young rabbit, there were only a few well-picked bones left to tell of the tragedy."

In the case of the whelk—a typically carnivorous mollusc—we get embryonic cannibalism: the stronger and older devour the younger and weaker. It is a case of *furiosus furore suo punitur*, illustrating the self-immolation of "failing species," i.e., such as have

wandered away far from Symbiosis, and have thus become engaged upon suicidal evolution.

Orthodox biologists see nothing abnormal in such developments. Some have instead seen fit to scoff at my ideas. But it is easier to scoff than to do better.

One could easily multiply instances of the above kind. They make it appear very feasible that evil communications in the end dispose the cells to like behaviour, and they show that on many counts suicidal developments must be regarded as the alternative of Norm-Symbiosis.

In his afore-mentioned article on the "Integration in the Living Organism," Prof. W. Bayliss states that the internal secretions, especially those affecting growth, have an obvious resemblance to the accessory food factors, or Vitamines. This resemblance, I believe, is important, since it marks the kinship of Vitamines and hormones. Prof. Bayliss is careful to add that the Vitamines have to be supplied to animals from the outside, ultimately from vegetable food, since plants only are able to make them.

But, one would ask, who else but the plant is in a similar way the source of hormones (contained in the internal secretions) too?

Again we are thus directed to Norm-Symbiosis as the great source of wholesome stimulation, wholesome direction of evolution.

Is there possibly any other source that could supply the vitally important chemical substances, conveying indispensable inorganic and cosmic influences, as well as is done by the plant? Scarcely.

Where else could we find the requisite experience, the requisite high specialisation, the necessary symbiotic awareness of the needs of others, the delicate adjustment

to the ends in view? Evidently our trust must be increasingly, not diminishingly, in Symbiosis.

The Vitamines have long been supposed to be the mother substances of the hormones. In other words, substances engendered in the ordinary course of Norm-Symbiosis, find their use, in a slightly modified form, in internal Symbiosis. Norm-Symbiosis is, in an important sense, the mother of internal Symbiosis.

There are other very similar phenomena, corroborating this view: scents were first produced by flowers in order to attract insects. We may compare them to the Vitamines, inasmuch as both are media of biological Symbiosis. But the males of many butterflies, attracted by such scents, in their turn produced the same or similar scents, with which to attract their females. We may liken them to the hormones, inasmuch as either serve in internal Symbiosis. Obviously there is a close kinship between these scents *qua* symbiotic media, and the case is on a par with that of Vitamines and hormones.

Prof. Bayliss tells us that in neither case (Vitamines and hormones) do we know the chemical nature of the substances concerned.

Actually, therefore, we may predicate more with regard to their socio-physiological, than their chemical nature—another reason for according only a second place to bio-chemistry.

Much the same interpretation applies to Prof. Bayliss' further remarks on "integration." He says: "It may turn out that we have to do with minute traces of metallic elements perhaps some of the rare metals. In that connection we are reminded of the necessity of zinc, in extremely small amounts, for the optimal growth of the mould Aspergillus. Certain of the endocrine organs may, indeed, have the function of supplying in an active or

utilisable form some particular element, as appears to be the case with the thyroid gland in relation to iodine."

We may say that it is the duty of the glands to metamorphose into stimulations appropriate to internal Symbiosis the raw products provided by Norm-Symbiosis. In either case ideally suitable substances have to be supplied to partners, and the respective duties represent no trifling tasks ; be it to glands or to plants.

The practical question thus arises as to the conditions under which the plant is best able to specialise in Norm-Symbiosis and to supply inorganic stimuli most adequate to Symbiogenesis ?

The plant, as already noted, is much hampered by the predacity of many animals. Such predacity may assume large proportions, and thereby hangs many a tale of natural history, as of health and disease. A general survey of food habits amongst animals which live exclusively on plant products shows that, as the norm of life, the animal is content with special parts of the plant, and that there is no inherent need for the animal to be unduly destructive *vis-à-vis* the plant, the prevailing relation being, on the contrary, one of "live-and-let-live."

Large numbers of animals, however, are immoderate, and some have even turned plant-assassins. They have spurned the controlled life of Symbiosis and are getting food feloniously. Hence there is need of protection on the part of the plant. As Weismann says, if the green parts of the plant were left defenceless at the mercy of the multitudes of herbivorous animals, it would not be long before they were exterminated from the face of the earth, for the animals would devour unsparingly whatever was within their reach. There is, therefore, an astounding number of devices by which the plants evade such a fate.

The diversity of contrivances surprises us who have long been blind to the pact between animal and plant.

But the metabolism of a plant is certain to suffer if it is forced to contrive defences in many directions against predacity; and this must divert its energies from the manufacture of substances needed for Symbiogenesis, and provide instead the foundation to pathogenesis. The animal cannot eat the cake and have it, and plant-assassination in the end means suicidal evolution, just as licentiousness on the part of tissues in the individual body may mean cancer. I have elsewhere dwelt on the nemesis of plant-assassins (*World's Work*, July, 1921). Such animals, lacking essential control, turn acromegalic. That is to say, they suffer from glandular anarchy and tend to monstrous size with many stigmata of disease in their structure. They have lost the sense of proportion in many things. This sense is preserved by those types alone which comport themselves decently, i.e., in accordance with the dictates of Symbiosis, which are those of bio-morality, or of bio-sociality. The plant misused, in one way or another imparts disease.

It is of some interest in this connection to examine another theory of suicidal evolution that has recently been put forward by Dr. W. D. Lang in connection with the history of the Fossil Bryozoa, specially studied by this investigator.

Dr. Lang stresses the tendency to increasing calcification as constituting suicidal evolution. He believes that the ancestral forms were horny ("chitinous") like the seamat, and that some began to strengthen their walls with carbonate of lime. Protective and advantageous at first, this had proved fatal in the long run, for the secretions of lime, once begun, increased from

generation to generation until in the final terms of that lineage all the openings of the cells were blocked by lime deposit and the creature was buried under the products of its own activity. He considers this phenomenon as general in the animal kingdom, and instances the extinction of the Irish Elk as due to the overgrowth of its antlers. It is true the races may continue to live happily for long, if not for ever, after beginning to secrete lime ; but this, says Dr. Lang, is only because excessive calcification is checked by some other internal secretion of the animal. The tendency to over-calcification is ever there, but inhibited. Remove the inhibition, and the usual unhappy result will follow.

Evidently the problem of " suicidal evolution " resolves itself, like that of disease and degeneration in general, into one of control—control from within and from without. Inhibition of pathological function, as here spoken of, is only another word for symbiotic restraint. Every gland depends for its rightful action upon the co-operation of the other glands (internal control), and, in a wider sense, upon co-operation with biological partners (external control).

We shall see presently that the plant itself becomes over-burdened with lime as a result of unsymbiotic behaviour on the part of the animal, and it is intelligible that such overcharge, by way of nemesis translates itself to the animal, which thus becomes, not only " buried," but also poisoned as the result of its own activity. Undue calcification, then, is but one form of nemesis due to a divorce from Symbiosis.

In my article on " Plant-Assassins " it was pointed out that the Elk, or Moose (mentioned by Dr. Lang) is a stark plant-assassin. It is a very destructive animal in the forest, rearing up on its hind legs to eat off twigs

growing high up and "riding down" young trees by straddling the stem and pressing them down till it can reach the crown. It is capable of exterminating those trees, the foliage of which it likes. That is to say, it is wont to destroy the goose that lays the golden eggs, and it must suffer the consequences of such suicidal behaviour. The animal is acromegalic, and, like innumerable carnivores and parasites, shows a loss of sense of proportion.

The same sequence is presented by the Megatherium, the giant sloth of South America, the remains of which at first presented a puzzling problem, as they unquestionably belonged to an animal allied to the sloths, which haunt trees to feed upon their foliage. But the giant sloth was so colossal that no tree could have borne its weight. The animal was from sixteen to eighteen feet long, and presumably lived upon the ground. When it desired leaves above its reach, it stood upon its hind legs, clasped the trunk of the tree with its front limbs, and, with a mighty heave, either broke the tree across, or tore it up by the roots; when it could then browse upon the leaves at its ease.

Monstrous is that monstrous does, so one might well comment from the point of view of evolutional pathology.

The gorilla, too, has been guilty of similar biological misconduct, and to this, more than to any other cause, may be attributed its marked degeneracy as an anthropoid.

Nor is the case essentially different from that of the parasites of palæozoic age studied by Dr. John M. Clarke, whose book was mentioned in the above. The healthy evolution of these animals became impaired through loss of locomotion and mobility, which, amongst other drawbacks, must have diminished the capacity for Norm-Symbiosis.

Dr. Clarke, who is described as the distinguished palæontologist who directs the New York State Museum at Albany, goes so far as to look upon parasites as abnormal and even "unrighteous." Very few biologists would go the same length with him. Most of them are naïve enough to regard parasites as normal. Some of them have nothing but badinage for any other view, however well supported.

It is clear that the term "internal secretions" is to some extent a misnomer. It is apt to cause it to be overlooked that the vital potencies of these body-fluids are in reality derived from the plants, which furnish appropriate stimuli, if they are treated decently, and poisonous stimuli when they are unfairly treated.

The internal secretions, we may take it, are ideally suited as natural media of harmonious stimulation, because they have the sanction of Symbiogenesis behind them. Their value is to stimulate all parts harmoniously to co-operative and widely useful work. The roots of glandular anarchy, as of anarchy amongst the tissues, thus lie deeper than has hitherto been supposed. It is futile to look for a local cause alone. Just as an active secreting gland receives an increased supply of blood containing sugar and oxygen, by dilation of the blood vessels to it, just as the circulation of the blood is so arranged that the brain, as the most valuable part, receives the best supplies, so, in the web of life, those animals most active in useful Symbiosis receive the best supplies of ideal stimulation. Those not so active and less valuable can only receive inferior supplies. The latter class will probably feed promiscuously and even exceed in size the genuine symbionts. But this is done at the price of future ruin. An animal which is by its behaviour excluded from the best organic fare, is

obliged to put up with inferior pabulum. The physiological economy of an animal is like the economy of a state in that bad currency drives out good. It is of some importance to remember this application of Gresham's law of currency to physiology.

The greater the number of plant-assassins, the larger become the variety of alkaloids which the plant is driven to produce. This means a great waste, which is certain to retard and to foil evolution in many directions.

Some plants deposit silicic acid in their cell-tissues, or develop in addition a very thick epidermis, so that they afford at the best an unpleasant food, e.g., many grasses, the horse-tails, the rhododendrons, and the bilberry.

In other plants protection is afforded by means of some acids, especially oxalic acid like in the wood-sorrel (*Oxalis acetorella*), the sorrel (*Rumex*) and the species of Begonia.

Weismann tells us that although it is true that the majority of plants cannot prevent the snails from creeping upon their stalks, yet they do not serve them in any great degree as food, since the green parts often resist their mastication and digestion.

Thus the lime encrustation which covers the stoneworts (Chara) prevent snails from eating them. If the lime be dissolved by means of acids, and the plant then offered to the snails, they will eat it greedily.

All of which shows that over-calcification may begin with the plant, and may be the result of the animal's own predacity, which distorts the normal symbiotic relation. Chitin is one of the substances forming the hard parts of many animals, as those of the jointed-footed ones, the Arthropods for instance. It seems to be sweated off like a secretion. Chemically it is

regarded as a derivative of the carbo-hydrates. In other words, the raw material is provided by the plant. But the elaboration of carbo-hydrates on the part of the plant depends in many ways on Norm-Symbiosis, and, hence, any disturbance of such Symbiosis must alter the output, which may, in turn, react unfavourably upon the evolution of the dependent animal.

Again, there is the case of the "raphides," those microscopic crystallic needles of oxalate of lime, pointed at both ends, which lie close together in the tissues of many plants. Cuckoo pint, the narcissi, the snowdrops, the squill and the asparagus, contain these raphides, and all these plants are spared by snails because during mastication they are unpleasantly affected by the raphides. Even the voracious field-slug rejects them.

Of course, the raphides do not protect against all animals. They are effective against rodents and ruminants, and also against locusts. But a number of caterpillars seek out by preference just those plants which contain raphides. This may have a significance of its own. It is possible for a plant to be at the same time poisonous to one and non-poisonous to another animal. Much depends on the parts the animal requires.

It is similarly possible for an animal to adapt itself to the wholesale ingestion of raphides, although in so doing it may induce that form of suicidal evolution by over calcification to which Dr. Lang calls attention.

Broadly speaking, one may say that an herbivorous animal which has become inured to the deterrants of the plant in the shape of raphides, alkaloid poisons, etc., etc., is one which has largely lost bio-social compunction and orientation and to have started instead on a course of suicidal evolution.

Some butterflies, the caterpillars of which feed on poisonous plants, it is true, thereby become inedible to most birds. They are *pro tanto* protected. The risk of health in some cases may be preferable to that of life.

It is significant in any case that so much that is protective in animal economy goes back to the plant. The plant, driven to protect itself against animal predacity, furnishes, as it were, the raw products appropriate to the evolution of " hormones " (messengers) of disease in the animal body.

A bird that has once eaten an " inedible " butterfly, does not, as a rule, care to taste another a second time.

But the cuckoo is one that has long unheeded the warning of so paltry a guardian as taste. It devours a species of " protected " hairy caterpillars despised by other birds. That it has lost all sense of proportion is seen by the fact that it is most voracious and that its intestine often shows an " encrustation " consisting of hairs. It is quite probable that the cuckoo's criminal habit in victimising other birds was favoured by its inordinate feeding habits, which necessitated a frequent change of preserves, so as to maintain the supply of the favourite caterpillars.

And thus we see again that everywhere, with the advent of unsymbiotic habits, we come across the seamy side of life. We found that the orchids have lapsed from Norm-Symbiosis, and it is not a little significant in this connection to remember that at least some of them are exceedingly malodorous. Such offensive odours as theirs, too, may be classified under the head of messengers of disease.

Again, those mammalia which have long forsaken Symbiosis, like the felines, for instance, are frequently notorious as evil smelling pests. Not only do they emit

offensive odours, but they are also, scavenger-like, attracted in their turn by the emanations of disease.

Look upon the lowliness of those mammalia still further removed from Symbiosis. There is the famous duck-billed platypus, or water-mole, the Ornithorhyncus, a mammal laying eggs in reptile fashion—a creature with a flattened beak, resembling that of a duck, with short-webbed fore-feet; with short hind-feet, armed with a highly poisonous spur; with a long tail, ridiculously small eyes, and no ears! It feeds on grubs and small shell-fish. Its staple diet seems to be furnished by a small, hard-shelled mollusc, *Corbicula nepeanensis*. It evidently obtains the pabulum appropriate to an abnormal metabolism, to disease and to retrograde, if not suicidal, evolution. The wherewithal appropriate to normal metabolism meanwhile goes to more righteous animals, which excel in evolution.

Look upon another mammal, which shares with the duckbill the distinction of laying eggs: the echidna, or spiny ant-eater, of Australia and New Guinea. It is an equally paradoxical creature, and its unsymbiotic feeding habits certainly do not seem to entitle it to a high place in life.

To a Weismann all this appears as normal and fair; as "survival of the fittest," "adaptation," "zuchtwahl," and the like. He is not even aware that we are here dealing with a chapter of disease and of evolutional pathology, which no one knows where they may begin. The worst of it is that the musty formulæ of his school have prevented the light of day from penetrating these corners of the biological field as they should have been penetrated.

According to Weismann, the Alpine grazing grounds serve well to illustrate how great may be the advantage

which protective devices give to a species of plants. Much to the annoyance of herdsmen, who endeavour to extirpate them, as far as possible, enormous masses of rhododendrons often cover whole stretches, because their hard silicious leaves cannot be eaten, and many other plants despised of cattle flourish and increase on the grazing runs like the repulsive, bitter, large *Gentiana asclepiadea*, the malodorous *Aposeris foetida*, and various ferns of disagreeable taste.

But does it exhaust the significance of the phenomenon to state that such protection is useful to plants ? Assuredly not. This is only a part significance. Evidently the protected plants here have obtained the upper hand because the grazing animals failed to treat their useful food-plants with the forbearance and consideration they deserve. Instead of symbiotic moderation, the animals have shown positive predacity, thus destroying the best plants and leaving the survivors with a perverted metabolism—negative in co-evolution, and often a source of disease and of " suicidal evolution " or " contre-évolution " (see the chapter under this heading in *Symbiosis: a Socio-Physiological Study of Evolution*).

That it is well in the power of animals to assist their useful partner-plants in many ways, though it be not always so strikingly evident, may be seen from the following account of the Agricultural Ants of Texas, reported by Prof. J. Arthur Thomson in his *The Biology of the Seasons :* " These red-bearded ants (*Pogonomyrmex barbatus*) weed out circular discs in open ground, tolerating only the needle-grass (Aristida), whose seeds they gathered and stored along with others in underground granaries. Not a plant is permitted to intrude in the formicary bounds ; and, although often seen, it

was an interesting sight, often pushing through high weeds, to come upon one of these nests and observe the tall, tough vegetation standing in a well-nigh perfect circle around the edge of the clearing. The weeds had crowded up as closely as they dared, and were held back from the forbidden ground by the insects, whose energy and skill could easily limit their bounds. Surely ants capable of such work could readily have cleared away growing stalks of the Aristida. In fact, scarcely had the seeds matured in the late summer, when the ants are said to clear away the dry stalks in order to make way for the new harvest."

Similarly ants are known to protect trees against animal enemies, and in general it may be said that the animals by their behaviour help to determine the flora of their district. The response of the plant to symbiotic treatment is truly astounding. The phenomenon would be quite mysterious save for the explanation of a long-protracted co-evolution between plant and animal, during which the plant shone as a kind of universal provider, though one constraining the provided to counter-services.

In the matter of counter-service, the plant seems to argue, as it were, that if parts of its substance are useful to the animal, it is unavoidable and right that the animal should assume some of the duties of defence and of care of progeny. Many plants surrender their defences in cultivation, using the respective energies instead to increase outputs of substances useful to their partners.

The whole case is reminiscent of matrimonial obligations amongst men, as, for instance, the anciently safe-guarded right of the wife arising from the fact of cohabitation. It reminds us of the responsibilities of sex, which were recently described by a lady writer thus :

" Deep in the heart of the majority of women is the desire not to have to think, but only to feel. This leads all who can get there into the greatest and quite the most esteemed of the professions open to women, the profession of marriage ; because, once in that, somebody else does the thinking necessary to procure food and shelter, and the woman can concentrate on what she is best fitted for, the development and dissemination of agreeable emotions."

It is, in other words, the case of reciprocal differentiation in Symbiosis.

> Ewig aus der Wahrheit Schranken
> Schweift des Mannes wilde Kraft.

But the eternal feminine is for ever the guardian of more legitimate influences. Again, as Schiller has it :

> Aber auf treuerem Pfade der Gefuehle
> Wandelt die Frau zu dem goettlichen Ziele."

Just as the legitimate claims of the " female of the species " have come to be increasingly recognised, so those of the plant, as a partner, though a weaker vessel, will have to be increasingly respected in the future, to the benefit alike of health and of morality.

Every day, too, we hear more of the " far-sighted " faculties of plants, such as that, for instance, of making provision for the sowing of their seeds after they themselves are dead, as was reported the other day by Prof. (now Sir) F. Keeble, in the case of the Russian steppe-grass.

So, too, it is being recognised by a handful of writers that morality is a product of evolution and inseparable from sentient life, its dim beginnings going back beyond all human knowledge.

In *Symbiosis* I have tried to show that human, i.e., conscious morality, has arisen out of unconscious bio-morality, and is largely dependent for its sanctions, past and present, upon bio-morality, and, further, that every stage of life possesses its corresponding degree of mind and of consciousness.

The conclusion, however, which we may more particularly draw from the above study is that the prevention of disease and of racial decline requires behaviour which is widely useful and legitimate in a sense agreeable to co-evolution between the "kingdoms"; that disease and extinction represent the nemesis of bio-morally unrighteous conduct—forms of retribution due to a divorce from Symbiosis.

Integration and division of labour are of little avail apart from Symbiosis. The differentiation and the perfection of a part are useful to the organism only in so far as they can assist the other parts in the accomplishment of their function and the organism, as a whole, in the discharge of its functions in the web of life.

Modern medicine begins to speak of a third factor in disease. But in this it has long been forestalled by Emerson, who shrewdly observed that there is a third silent party to all our bargains.

It is that third party whom we foolishly forget when we fondly imagine ourselves to be irresponsible as Lords of Creation—an attitude which is of a piece with that of Belshazzar, king of Babylon, who was weighed in the balances and found wanting, and whose doom was sealed when he boasted :

> Jehovah, Dir kuend' ich auf ewig Hohn,
> Ich bin der Koenig von Babylon.

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